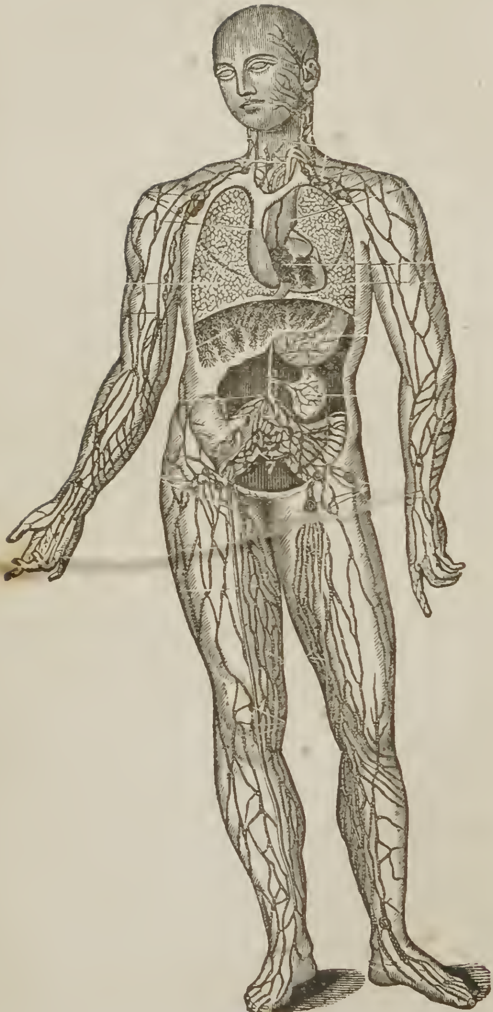

# ANATOMY

AND

# PHYSIOLOGY:

DESIGNED FOR

ACADEMIES AND FAMILIES.

By CALVIN CUTTER, M. D.

Sixth Stereotype Edition,

WITH

OVER TWO HUNDRED ENGRAVINGS.



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# PREFACE.

AGESILAUS, king of Sparta, when asked what things boys should learn, replied, "those which they will *practise* when they become men." As health requires the observance of the laws inherent to the different organs of the human system, so not only boys, but girls, should acquire a knowledge of the laws of their organization. If sound morality depend upon the inculcation of correct principles in youth, equally so does a sound physical system depend on a correct physical education during the same period of life. If the teacher and parents who are deficient in moral feelings and sentiments, are unfit to communicate to children and youth, those high moral principles demanded by the nature of man, so are they equally incompetent directors of the physical training of the youthful system, if ignorant of the organic laws and the physiological conditions upon which health and disease depend.

Hence, the study of the structure of the human system, and the laws of the different organs, are subjects of interest to all, — the young and the old, the learned and the unlearned, the rich and the poor. Every scholar, and partic-

ularly every young miss, after acquiring a knowledge of the primary branches, — as spelling, reading, writing, and arithmetic, — should learn the structure of the human system, and the conditions upon which health and disease depend, as this knowledge will be required in *practice* in after life.

"It is somewhat unaccountable," says Dr. Dick, "and not a little inconsistent, that while we direct the young to look abroad over the surface of the earth and survey its mountains, rivers, seas, and continents, and guide their views to the regions of the firmament, where they may contemplate the moons of Jupiter, the rings of Saturn, and thousands of luminaries placed at immeasurable distances, * * that we should never teach them *to look into themselves;* to consider their own corporeal structures, the numerous parts of which they are composed, the admirable functions they perform, the wisdom and goodness displayed in their mechanism, and the lessons of practical instruction which may be derived from such contemplations."

Again he says, "one great practical end which should always be kept in view in the study of physiology, is the invigoration and improvement of the corporeal powers and functions, the preservation of health, and the prevention of disease."

The design of the following pages, is to diffuse in the community, especially among the youth, a knowledge of Human Anatomy, Physiology, and the Laws of Health. To make the work clear and practical, the following method has been adopted.

1st. The structure of the different organs of the system has been described in a clear and concise manner. To render this description more intelligible, two hundred and fifteen engravings have been introduced, to show the situation of the various organs. Hence, the work may be regarded as an elementary treatise on anatomy.

2d. The functions or uses of the several parts have been briefly and plainly detailed; making a primary treatise on human physiology.

3d. To make a knowledge of the structure and functions of the different organs *practical*, the laws of the several parts, and the conditions on which health depends, have been clearly and succinctly explained. Hence, it may be called a treatise on the principle of Hygiene, or health.

To render this department more complete, an Appendix has been added, in which the appropriate treatment of Burns, Wounds, dangerous Hemorrhage from divided arteries, the management of Persons apparently Drowned, the removal of Disease, and the antidotes for Poisons, have been detailed, that persons may know what *should be done*, and what *should not be done*, until a surgeon or physician can be called.

In attempting to effect this, in a brief elementary treatise designed for schools and families, it has not been deemed necessary to use vulgar phrases for the purpose of being understood. The appropriate scientific term should be applied to each organ. No more effort is required to learn the meaning of a *proper*, than an improper term. For example: a child will pronounce the word as readily, and obtain

as correct an idea, if you say *lungs*, as if you used the word *lights*. A little effort on the part of teachers and parents, would diminish the number of vulgar terms and phrases, and consequently, improve the language of our country. To obviate all objections to the use of proper scientific terms, a Glossary has been appended to the work.

The author makes no pretensions to new discoveries in physiological science. In preparing the anatomical department, the able treatises of Wilson and Cruveilhier have been freely consulted. In the physiological part, the splendid works of Carpenter and Dunglison have been perused. Many valuable hints have been obtained from the meritorious works upon Physiology, of Combe, Lee, Rivers, and others.

We would present our thanks to the teachers in New England and New York, who have made many valuable and practical suggestions for this edition of the work.

We are under particular obligations to Albert J. Bellows, M. D., Lecturer on Anatomy and Physiology at the Charlestown Ladies Seminary, and to Mr. James Ritchie, Principal of the Academy at Duxbury, Mass., who carefully examined the manuscript for the third edition.

To the examination of an intelligent public, the work is respectfully committed by

THE AUTHOR.

# TO TEACHERS AND PARENTS.

In the arrangement of this edition, the Physiology has been separated from the Hygiene, or the conditions on which health depends. Thus, we have made three distinct divisions — 1st, Anatomy. 2d, Physiology. 3d, Practical Suggestions — to which may be added a 4th, The treatment of Accidental Injuries, in an Appendix.

As the work is divided into chapters, the subjects of which are complete in themselves, the pupil may commence the study of the structure, use, and laws of the several parts of which the human system is composed, by selecting such chapters as fancy or utility may dictate, without reference to their present arrangement — as well commence with the chapter on the Bones, as on the Skin. Again, as there are three divisions in each chapter, the Anatomical sections may be only carefully read, while those upon the Physiology and Practical Suggestions, should be attentively studied. Such is the arrangement of the work, that, if the period of study is brief, any chapter may be omitted, but we would suggest an attentive perusal of those upon the Skin, Muscles, Digestive Organs, Lungs, Brain, and the Appendix.

The student would find it advantageous to consult the copious Glossary, as the technical terms are there not only defined, but each syllable is divided, and the accented one designated. The acquisition of a correct pronunciation of

the technical words, is of great importance, both in recitation and in conversation.

If the illustrating engravings were drawn upon a black-board, it would serve to impress more strongly the form and relative positions of the several organs upon the memory.

The questions at the bottom of each page, are designed for *young* scholars. The leading questions are given in italics, in order that advanced students, if preferred, may recite the text in the form of topics.

To parents and others we would say, that about two thirds of the present work is devoted to a concise and intelligible description of the uses of the important organs of the human body, and to show how such information may be usefully applied, both to the preservation of health, and the improvement of physical education. To this has been added directions for the treatment of those accidents which daily occur in the community, making it a treatise proper and profitable for the FAMILY LIBRARY as well as the school-room.

# CONTENTS.

# ANATOMY AND PHYSIOLOGY.

## CHAPTER I.

Anatomy is the term applied to the description of the mechanism or structure of the parts of the system. It is derived from the Greek *ana*, through, and *temnô*, I cut; and signifies the art of dissecting, or artificially separating the different parts of the animal body.

Physiology is the science of the properties and functions of animals and plants. It is derived from the Greek *phusis*, nature, and *logos*, a discourse.

Human Physiology treats of the laws by which the various functions in man are carried on.

Comparative Physiology treats of the functions of other animals than man, with a view to compare their structure with that of human beings.

Vegetable Physiology treats exclusively of plants.

The kingdom of nature is divided into organic and inorganic bodies. *Organic* bodies are such as possess organs, on the action of which depend their growth and perfection. This division includes animals and plants.

*Inorganic* bodies are devoid of organs, or instruments of life. In this division are classed the earths, metals, and other minerals.

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What is anatomy? What is physiology? Of what does human physiology treat? What does comparative? What does vegetable physiology? Define organic bodies. Define inorganic bodies.

In general, organic matter differs so materially from inorganic, that the one can readily be distinguished from the other. In the organic world, the parts are mutually dependent on each other for support. Break the tiny stem of a rose, and it soon withers; or girdle the bark of the forest tree, and it dies, because it cannot receive support from the ascending sap. So, in man; amputate an arm, and its vitality ceases, for the vessels communicating with it have been severed. But, in inorganized bodies, the results are different. Break off a piece of flint, and it is exempt from those internal changes and effects, which impair and finally destroy organic structure and arrangement.

"Organized bodies always present a combination of both solids and fluids; — of solids differing in character and properties, arranged into organs, and these endowed with peculiar functional powers, and so associated as to form of the whole a single system; — and of fluids, contained in these organs, and holding such relations to the solids, that the existence, nature, and properties of both, mutually and necessarily depend on each other.

Every inorganic body consists wholly, either of the solid, or liquid, or gaseous, form of matter; and all its parts are alike in structure and properties, and may exist as well when separated into portions or broken into fragments, as when united in a single volume or mass. But whether solid, liquid, or gaseous, — whether composed of one or more of the chemical elements, the aggregations and arrangements of the atoms of matter, in every substance, take place according to fixed, constitutional laws, and in a regular and determinate manner; so that the intimate structure of each form of matter is always in accordance with its own nature."

Organized bodies increase in size by a process called nutrition, which consists in imbibing substances, and converting them to their own nature, by means of internal organs. They have, within a certain range, their specific proportions, shape, and size, by which they are not only distinguished from inorganic bodies, but specifically from each other. Inorganic bodies, on the contrary, increase in size, or change in shape,

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Can organic and inorganic bodies be readily distinguished from each other? What do organized bodies always present? In what forms do inorganic bodies exist? What distinctive difference between inorganic and organic bodies? How do organized bodies increase in bulk? Inorganic?

by the simple accretion of matter to their surfaces. Thus it will be seen that organized bodies augment in bulk from within, and inorganized bodies from without.

Though animals and vegetables derive their origin from pre-existing bodies of the same kind, and possess the faculties of nutrition and reproduction, yet the animal kingdom is as distinct from the vegetable, as the latter is from the mineral kingdom. The fundamental endowments which distinguish animals from vegetables, are *sensation* and *voluntary motion.* The latter are destitute of these qualities. Another characteristic of animals, is a predominance of the fluid over the solid parts. This causes them to decompose sooner than vegetables; and common observation shows, that those plants which abound in fluids, decay sooner than those of a more fibrous or solid texture.

Vegetables are nourished by the substances immediately around them, — as air, water, and the saline properties of the soil. Their support is drawn from without, by absorption at their surface, or by means of roots. Animals, on the contrary, derive their nutriment from a great variety of sources. The aliments, previous to being absorbed and diffused through the different parts of the body, to afford nourishment to the organs, are received into an internal cavity, where they are prepared for nutrition.

The differences between the animal and vegetable kingdoms are, in general, sufficiently obvious, but, in some few instances, their distinguishing characteristics are not so evident. In the lowest order of animals, as the sponge, coral, &c., we find them to be as firmly attached to the soil, as most vegetables; while, on the other hand, some vegetables float in the water, as many kinds of sea-weed, and are never attached to the soil.

All organized bodies have a limited period of life, and this period, whether of vegetables or animals, varies with every species. In some the period is limited to a single day, — in many plants to a single summer; while some animals, as the elephant, live more than a century; and some trees, as a species of oak, and the olive, are supposed to live a thousand years or more. This period of life is shortened by

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What are the fundamental endowments which distinguish animals from vegetables? What is another characteristic of animals? How are vegetables and animals nourished?

disease; but disease is under the control of fixed laws, and rarely occurs to vegetables or animals in their native condition, while man is so subject to disease, that his average length of life is less than half its natural period. These diseases come not by chance; they are penalties for breaking the laws of our being, — laws which we are capable of understanding and obeying. If we carelessly cut or bruise our flesh, pain and soreness follow, to induce us to be more careful in the future; or, if we take improper food into the stomach, we are warned, perhaps immediately, by a friendly pain, that we have done wrong. Sometimes, however, the penalty does not directly follow the sin, and it requires great physiological knowledge to be able to trace the effect to its true cause. If we possess good constitutions we are responsible for most of our sickness; and bad constitutions or hereditary diseases are but the results of the same great law, — the iniquities of the parents being visited on the children. In this view of the subject, how important is the study of physiology! For how can we expect to obey laws which we do not understand?

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Is disease under the control of fixed laws? Why is the study of physiology important?

# CHAPTER II.

## ANATOMY AND PHYSIOLOGY OF THE SKIN.

THE SKIN is a membranous covering, enveloping the bones and other parts of the system. In youth, and in females particularly, it is smooth, soft, and elastic. In middle age, and in males, it is firm, and rough to the touch. In old age, in persons who are emaciated, and about the flexions of the joints, it is thrown into folds. The interior of the body, like the exterior, is covered by a skin, which, from the constantly moistened state of its surface, is denominated the *mucous membrane.* At the various orifices of the body, the exterior skin is continuous with the internal skin.

The skin, to the naked eye, appears composed of one membrane. But examination has shown that it consists of two layers of membrane; namely, the *cuticle*, or *scarf skin*, and the *cutis vera*, or *true skin*; — combined, they form the animal membrane, — the skin. These layers are widely different from each other in structure, and perform very different offices in the animal economy.

### ANATOMY OF THE CUTICLE.

The CUTICLE, from the Latin, *cuticula*, is the external layer of the skin; it is also called the *epidermis* and *scarf skin.* This membrane is thin and semi-transparent, and resembles a thin shaving of soft, clear horn, and bears the same relation to other parts of the skin, that the rough bark or ross of a tree does to the liber or living bark. The cuticle has no perceptible nerves or blood-vessels; consequently, if it be cut

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*What is the skin?* Mention its different appearances in its different conditions in the human frame. Is the interior of the body as well as the exterior covered by a skin? What is this interior membrane called? Why has it received this name? How many layers of membrane has the exterior skin of the body? What are they? Do these layers of membrane differ in structure? Do they perform the same offices in the animal economy? *Give the anatomy of the cuticle.* By what other names is it called? is the cuticle possessed of nerves?

or abraded, no pain will be felt, and no fluid will ooze from it. It is the cuticle of the finger, which the seamstress pierces in the operation of sewing; and it is the same membrane which the cutler shaves, in order to test the sharpness of his blades.

This membrane varies in thickness in different parts of the system,—from the thin, delicate skin upon the internal flexions of the joints, to the thickened covering of the soles of the feet. The greater thickness of the cuticle of the palms of the hands and soles of the feet, is manifestly the intentional work of the Creator; for it is perceptible in infants, even at birth, before exercise can have had any influence. Friction, if moderate, and often repeated, will increase it in thickness, as may be seen in the thickened cuticle of the lady's finger that plies the needle, and in the hard or callous appearance of the hands of farmers, masons, and other mechanics.

## PHYSIOLOGY OF THE CUTICLE.

The cuticle is horny and insensible, and is a sheath of protection to the highly sensitive skin (*cutis vera*) situated beneath it. The latter feels; but the former blunts the impression which occasions feeling. In some situations, the cuticle is so dense and thick, as wholly to exclude ordinary impressions. Of this we see an example in the ends of the fingers, where the hard and dense nail is the cuticle modified for the purpose referred to. Were the nervous tissue of the *true skin* not thus protected, every sensation would be unpleasant, and contact with external bodies would cause pain. The cuticle, also, prevents disease, by impeding the evaporation of the fluids of the *true skin*, and the absorption of the poisonous vapors which necessarily attend various employments. It, however, affords protection to the system only when *unbroken*, and then to the greatest degree, when covered with a proper amount of oily secretion from the oil-glands.

The cuticle is, originally, a transparent fluid, exuded by the blood-vessels, and distributed as a thin layer on the surface

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Does the cuticle vary in thickness in different parts of the body? In what instance is a thicker cuticle provided? What reason have we to think this provision intentional? What effect has friction upon this membrane? *Give the physiology of the cuticle.* Wherein does it differ from the true skin beneath? How do we find it in some situations? Give an example. Relate the uses of the cuticle. When does it protect the system? What is the cuticle, originally?

of the true skin. While successive layers are formed on the exterior of the true skin, the external cuticular layers are converted into dry, flattened scales, by the evaporation of their fluid contents. The thickness of the cuticle is formed mainly from these scales.

The cuticle is, therefore, undergoing a constant process of formation and growth at its under part, to compensate for the wear that is taking place continually on its surface. A proper thickness of the cuticle is in this manner preserved; the faculty of sensation and that of touch are properly regulated; the places of the little scales, which are continually falling off under the united influence of *friction* and *ablution*, are supplied; and an action necessary, not merely to the health of the skin, but to that of the entire body, is established.

When examined chemically, the cuticle is found to be composed of a substance resembling the dried white of egg, or, in a word, *albumen*. This is soluble in alkalies, and these are the agents which are commonly employed for purifying the skin. Soap, is a compound of the alkali soda with oil, the former being in excess. When used for washing, the excess of alkali combining with the oily fluid, with which the skin is naturally bedewed, removes it, in the form of an emulsion, and with it a portion of any adhering matter. Another portion of the alkali softens and dissolves the superficial stratum of the cuticle, and when this is removed, the cuticle is free from all impurities. So that every washing of the skin with soap, removes the old face of the cuticle, and leaves a new one; and were the process repeated to excess, the latter would become so thin as to render the body sensible to a touch too slight to be felt through its ordinary thickness. On the other hand, when the cuticle and its accumulated impurities are rarely disturbed, the sensitiveness of the skin is impaired. The proper inference to be drawn from the preceding remarks is in favor of the *moderate* use of soap, to cleanse the skin.

The cuticle is interesting to us in another point of view, as being the seat of the color of the skin. The difference of color

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Describe the changes of this membrane. Show the necessity of this constant growth. What results from the cuticle being uniform in thickness? Of what is it composed? In what is it soluble? Why does soap cleanse the skin? Why should not soap be used in excess? How do impurities impair the sensibilities of the skin? In what other point of view is the cuticle interesting?

between the blonde and the brunette, the European and the African, lies in the cuticle, — in the deeper, and softer, and newly-formed layers of that structure. In the whitest skin, the cells of the cuticle always contain more or less of a peculiar pigment, incorporated with the elementary granules which enter into their composition. In the white races, the pigmentary tint is extremely slight, and less in the winter than in the summer season. In the darker races, on the contrary, it is deep and strongly marked. The various tints of color exhibited by mankind are, therefore, referable to the amount of coloring principle contained within the elementary granules of the cuticle, and their consequent depth of hue. In the negro, the granules are more or less black; in the European of the south, they are amber-colored; and in the inhabitants of the north, they are pale and almost colorless.

Color of the skin has relation to energy in its action; thus, under the tropics, where light and heat are most powerful, the skin is stimulated by these agents to vigorous action, and color is very deep; while in the frigid regions, where both light and heat are feeble, the lungs, liver, and kidneys relieve the skin of part of its duties. The same observation relates to summer and winter. The same law of color applies to animals, birds, and vegetables, as to man, as may be seen by comparing the plumage of the feathered songsters, the hues of plants and animals indigenous to the torrid zone, with those of the temperate and frigid zones. The colored stratum of the cuticle has been named the RETE MUCOSUM, or mucous coat of the skin, and described as a distinct layer by many physiologists.

## ANATOMY OF THE CUTIS VERA.

The CUTIS VERA, from the Latin, *cutis*, the skin, and *vera*, true, sometimes called the sensitive skin, or *corion*, performs the dissimilar offices of an organ of exquisite sensation, and

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In what part of the cuticle do we find the coloring matter? In what season of the year is the coloring matter less in the white race? To what is the color of the skin referable? Why have the races of the torrid zone darker complexions than those of the temperate or frigid zones? Do we observe the same law existing in animals? In vegetables? What is this colored stratum called by many physiologists? *Describe the cutis vera.* By what other name is this layer of membrane called? What offices does it perform?

of defence to the deeper parts of the body. The former is fulfilled by its superficial stratum or layer; the latter is effected by the entire thickness of the corion, but principally by its middle and deeper stratum. This is the portion of the skin which, by a chemical process, is converted into leather.

The defensive portion of the skin is constituted of excessively minute fibres, which are collected into small bundles or strands. These are interwoven with each other so as to constitute a firm, strong, and flexible web. In the superficial part of the true skin, the web is so close as to have the appearance of *porous felt;* but more deeply, the pores become progressively larger, and, upon the lower surface, have a diameter of about a line, or twelfth of an inch. This gives the under surface the appearance of a coarse web. The strands of the under surface of the true skin are connected with the fibrous web, in which the sub-cutaneous fat of the body is deposited; while the upper surface gives support to the sensitive or papillary layer which is bedded upon it.

The sensitive layer of the skin is thin, soft, uneven, pinkish in hue, and composed of blood-vessels, which confer its various tints of red; and of nerves, which give it the faculty of sensation. The unevenness of this layer is produced by little, elongated, conical prominences, technically termed *papillæ*, which are arranged in fine ridges, longitudinal and concentric, and is seen on the palms of the hands and the fingers. These papillæ are extremely minute, and imperceptible to the naked eye. As they exist in every part of the skin, their number is immense. In structure, every papilla is composed of a minute artery, vein, nerve and absorbent. In addition to these vessels, the cutis vera is supplied with oil-glands and tubes, and perspiratory glands and tubes.

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How is the former fulfilled? How is the latter effected? What portion of the skin is converted into leather by its union with tannin? How is the defensive portion of the cutis constituted? Where is the fat of the body deposited? Where is the papillary layer imbedded? Describe the sensitive layer of the skin. How is the unevenness of the true skin produced? How are the papillæ arranged? What is said of their size? Are they numerous? Of what is every papilla composed? What other vessels are found in the cutis vera?

## ANATOMY OF THE ARTERIES AND VEINS.

An ARTERY, from the Greek, *arteria*, is a small tube or vessel, through which the scarlet or pure blood of the skin passes. The larger arteries, which pass through the open meshes of the true skin, are subdivided into innumerable and very minute tubes, called *capillary* vessels. These capillary vessels form a beautiful net-work, upon the upper surface of the true skin. This vascular net sends a branch to each of the papillæ, which opens into and terminates in a minute vein. By the agency of this complicated system of vessels, the skin is supplied with the vast quantity of blood, necessary to sustain its functions.

Fig. 2.


Fig. 2. 1, 1, The cuticle. 2, 2, The colored layer of the cuticle. 3, 3, The papillary layer. 4, 4, The net-work of capillary vessels. 5, 5, The true skin. 6, 6, 6, Three arteries, that divide to form the capillary vessels. 7, 7, 7, The furrows between the papillæ. 8, 8, 8, Three clusters of papillæ magnified fifty diameters.

The VEINS, from the Latin, *vena*, are the vessels that convey blood to the heart. The minute capillary veins are as numerous as the capillary arteries, which they accompany.

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*What are arteries?* How are the capillary vessels formed? What do they form upon the upper surface of the true skin? How is the skin supplied with blood? Explain Fig. 2. *Describe the veins of the skin.* Are they as numerous as the capillary arteries?

They receive from the artery that portion of the blood, which is unfit for the nutrient and functional operations of the skin. The minute veins unite to form larger trunks, as small springs from the hill side coalesce to form rivulets.

Fig. 3.


Fig. 3, represents the arteries and veins of a section of the skin. A, A, Arterial branches. B, B, Capillary or hair-like vessels, in which the large branches terminate. C, The venous trunk, collecting the blood from the capillaries.

## PHYSIOLOGY OF THE CUTANEOUS ARTERIES AND VEINS.

The circulation of the blood through the arteries and veins of the skin, is most energetic under the following circumstances: 1st. When the heart acts with vigor. 2d. When the system contains a proper amount of healthy blood. This is is illustrated by the paleness of the skin, which follows the loss of large quantities of blood. 3d. When the muscles and limbs have been properly exercised. This is illustrated in the case of a person of sedentary habits, by the substitution, for his usual paleness, of the carnation glow of health, while riding or walking in the open air. 4th. When the brain and nervous system are in a healthy state. This is seen when we compare the flushed cheek of a person who is stimulated by hope and joyful expectations, with the paleness of the un-

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What do they receive from the arteries? What does Fig. 3 represent? What is the first condition that induces an energetic circulation of blood in the skin? The second? Give an illustration. The third? Give an illustration. The fourth? Give an illustration.

fortunate person who is depressed by grief. The influence of the mind upon the circulation of the skin, is also seen in the instantaneous suffusion in blushing. There, the minute arteries of the skin, through which the lymph or white blood usually passes, become suddenly dilated and filled with red globules of arterial blood. 5th. When the skin is kept at a proper temperature. This is seen by comparing the pallid, contracted, and wrinkled appearance of the skin, when exposed to cold, with the smooth, full, and increased color that attends and follows the application of heat. 6th. When the arteries and veins are not compressed by clothing, or by any other means. This is illustrated by the paleness produced when the skin is compressed by the finger or hand, which prevents the blood from passing through the arteries. Let the pressure be removed, and the color returns, from the restoration of the circulation. 7th. When the impure, saline, and oily matter, that collects on the skin, forming a pellicle, is frequently and regularly removed by ablutions, as this favors increased action of the oil-glands and perspiratory apparatus. This is demonstrated by comparing the dingy, pallid, and shrunken appearance of the skin before ablution, with the fullness and carnation glow which are exhibited after bathing.

## ANATOMY OF THE CUTANEOUS NERVES.

The NERVES, from the Latin, *nervus*, are spread over every part of the sensitive layer of the true skin. As a proof of this, no part of this tissue can be punctured with a fine needle, without transfixing a nerve, and inducing pain. In some parts of the system, the nerves are more abundant than in others; where the sense of feeling is most acute, we find the greatest number of nerves, and those of the largest size. Those parts which are most exposed to injury, are most sensitive. The conjunctiva, or skin of the eye, is pained by the presence of a particle of dust, because it would render vision imperfect. The lungs, also, would be injured by the smallest substance; they are therefore protected, by the exquisite sensitiveness of the lining membrane of the trachea, so that a particle of food or dust, is ejected by a convulsive cough,

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Give another. The fifth? The sixth? How is this illustrated? The seventh? How is this shown? *Describe the nerves of the skin.* Are the nerves more abundant in some parts of the system than in others? Where do we find the greatest number? Give illustrations.

before it reaches the lungs; while the bones, which are not exposed to injury, have, in health, scarcely any sensibility.

The nerves are more numerous in the upper, than lower extremities; in greater numbers upon the palm, than the back of the hand. They are, likewise, more abundant and larger at the extremities of the fingers, and in the lips, than in any other part of the body. The proboscis of the elephant, the extremities of the tails of certain species of monkeys, and the tentacula of some kinds of fish, receive a more abundant supply of sensitive nerves than other parts of their systems.

In the small papillæ, the nerve forms a single loop, while in papillæ of larger size, and endowed with a power of more exalted sensation, the nerve is bent several times upon itself previous to completing the loop. These little loops spring from a net-work of nerves, embedded in the upper porous stratum of the true skin at the base of the papillæ. This net-work of nerves receives its influence through nerves which take their winding course through the fat, distended openings of the deeper layers of the true skin.

Fig. 4.


Fig. 4. 1, 1, The cuticle. 2, 2, The colored layer of the cuticle. 3, 3, The papillary layer. 4, 4, The net-work of nerves. 5, 5, The true skin. 6, 6, 6, Three nerves that divide to form the net-work (4, 4.) 7, 7, 7, The furrows between the papillæ. 8, 8, 8, Three papillæ magnified fifty diameters.

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Mention the difference in the distribution of the nerves in various parts of the body. Is this difference also found in the lower order of animals? How are the nerves of the small papillæ arranged? How in the large papillæ? Where do these small loops spring from? From what source do these papillæ receive their nervous influence? Explain Fig. 4.

## PHYSIOLOGY OF THE CUTANEOUS NERVES.

*It is a law of the animal economy, that parts unlike in their structure, are different in their functional operations.* This is illustrated by the different structure and functions of the eye and ear. As the *nerves* differ from the other vessels and parts of the skin in structure, so we find a difference in their use or functions. An artery contains blood; if its coat be broken, the blood will flow from the wound. A nerve contains no blood, but it is the channel of communication between the parts upon which its minute filaments ramify, and the brain, — the centre of sensation and seat of the mind. If a filament of any nerve of sensation be wounded, the impression made upon it is communicated to the brain, and the mind becomes sensible of the injury of the nerve.

The nerves of the skin are of importance to us in two ways: 1st. Through them we receive many impressions that enhance our pleasures; as, the grateful sensations imparted by the cooling breeze in a warm day. 2d. In consequence of the sensitiveness of the nerves, we are individually protected, by being admonished of the proximity of destructive agents, and the destruction induced by them. This is illustrated by an incident related by Dr. Yelloly, in the 3d vol. of the Medico Chirurgical Transactions. A man who had been afflicted some years with a severe disease of a portion of the brain and spinal cord, was deprived of feeling in the lower extremities. He was directed by his attending physician to use a warm foot-bath. Intending to follow the directions given him, he immersed his feet in boiling water, which he supposed of a proper temperature. While his feet were immersed in the water, he experienced no sensation of an unpleasant nature. On withdrawing them, he was astonished to find the cuticle separated from the other tissues, by the effusion of water or serum, and thus producing a blister over the whole surface. Portions of the skin would suffer every day, were it not for the sentinel-like care exercised by the nerves. Impressions upon them are transmitted to the brain with as much speed and readiness, as the communica-

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*Give the physiology of the cutaneous nerves.* What law of the animal economy is here given? How illustrated? Of what importance are the nerves of the skin? What illustration is given?

tions by the Electro Telegraph of Prof. Morse. As the skin is continually exposed to the influence of destructive agents, it is important that the sentient nerves, provided for its protection, should be kept in a healthy state. The sensitiveness of the skin is effected by the following conditions.

1st. *The healthy or unhealthy, active or inactive state of the brain.* In sound and perfect sleep, the brain is inactive. In this state, ordinary impressions made upon the skin, are not observed by the sleeping person. Thus the arm may be blistered while sleeping, if it is exposed to the warm rays of the sun, and the individual will not be aware of it at the time. If there is compression of the brain, as when the skull bones are depressed, or disease of this organ, as in severe typhus fever, impressions made upon the sentient nerves of the skin will not be noticed, as the operations of the mind are suspended under such circumstances.

The varying health or condition of the brain, usually depresses or increases the sensitiveness of the skin. This is seen in *grief* and *fear*, which diminish, while *hope* and *joy* increase the impressibility of this tissue. It is not uncommon to see the unfortunate insane endure exposure to heat and cold with seeming impunity; whereas it would induce almost insupportable suffering to the sane man. Diseases of the heart, stomach, and lungs, alter the condition of the brain, and modify, to a greater or less degree, the sensitiveness of the skin.

2d. *The state of the conducting nervous trunks influences the sentient nerves.* If a nervous trunk is compressed or divided, the parts supplied by nervous filaments from the nerve, will be insensible to the impressions made upon them, and such impressions are not transmitted to the brain.

3d. *The quantity and quality of the blood modify the sensitiveness of the skin.* If the quantity of blood be diminished, the sensibility of the skin will be impaired. This is demonstrated by noting the effects of cold upon the cutaneous

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Why is it necessary that the sentient nerves be kept in a healthy state? What is the first condition upon which their health depends? Are ordinary impressions noticed in perfect sleep? Why not? When the brain is compressed? What effect have mental emotions upon the skin? Do diseases of the other organs affect the sensibility of the skin? How? What is the second condition upon which the sensibility of the skin depends? What the third? What effect has the diminution of blood upon the skin? Illustrate it.

tissue, the application of which contracts the blood vessels, and drives the circulating fluid from this tissue, which is shown by the paleness, as well as by the shrivelled appearance of the skin. And if this tissue be wounded, while under the influence of cold, little or no blood will exude from the divided blood-vessels, and but little pain will be felt. The chilling and contracting influence of cold upon the blood-vessels can be carried so far as not only to deprive the part of sensation, but of life.

The influence of the blood upon the sensibility of the skin is further demonstrated by the pain experienced when chilled extremities are suddenly exposed to heat. The nerves, by the sudden dilatation of the contracted blood-vessels, are put in vivid and rapid motion, which causes the painful and tingling sensation that we experience. In every part of the system, sudden changes produce unpleasant sensations, and frequently a diseased condition of the organs. Thus we may assert, that *all changes, to be either safe or pleasant, must be gradual.* When the hands, or other portions of the body, are frozen, or severely chilled, safety and comfort demand that circulation be invited to the parts by moderate exercise in a cool room. Immersing the parts in warm water, or holding them near the fire, causes pain, and frequently destroys the vitality of the limb. If the quality of the blood is impure, as when a person has breathed vitiated or impure air, the sensibility of the skin will be impaired.

*4th. The condition of the cuticle modifies the impression made upon the cutaneous nerves.* — 1st. When the cuticle has become thick and hard, like horn, as it does in the inside of the mason's hand, and others of similar trades, it enables them to ply their tools without much suffering, because the thickened cuticle diminishes the impressions made upon the nerves. 2d. When the cuticle is very thin and delicate, as in the hand of the lady who is unaccustomed to manual labor. Let her pursue some manual employment for several hours, and the extreme tenuity or thinness of the cuticle, will not protect the nerves and parts below from becoming irritated and inflamed; consequently, pain and blisters will be the inevitable result.

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How is the influence of the blood upon the skin further demonstrated? What causes the painful, tingling sensations, when we expose chilled limbs to heat? Should all changes in the animal economy be gradual? Why? What is the fourth condition upon which the sensibility of the skin depends?

3d. When the cuticle is removed by blistering or abrasion, the pain indicates that the naked nerves are too powerfully stimulated by the contact of external bodies. 4th. When the cuticle is coated with impurities, blended with the secretion from the oil-glands. In this case, the sensibility of the skin will be much less than when it is properly cleansed.

*5th. The sensibility of the cutaneous nerves is modified by being habituated to impressions.* If, for example, an individual should immerse his feet in moderately warm water, at first it might induce a smarting sensation; in a short time the nerves would not only become habituated to the *warm* water, but its warmth might be considerably increased. The same results follow, if an individual be exposed to cold. The impressions at first are highly disagreeable, but as soon as the nerves become accustomed to the surrounding atmosphere, they will impart the most agreeable sensations. To illustrate this, let a person from the tropical regions go to a colder climate, and the cool mornings of the latter will at first affect him unpleasantly; but, after a few days' exposure to the cooler air, the sensation will be far from being disagreeable. Take an opposite illustration. Let a person enter a room moderately heated; gradually increase the temperature, until it attains extreme summer heat; not only the cutaneous nerves, but the whole system, becomes habituated to the high temperature. From these facts we learn that the sensations are not always a correct index of the real temperature. A well-adjusted thermometer is the agent that will indicate it with unerring certainty.

## ANATOMY OF THE CUTANEOUS ABSORBENTS.

The ABSORBENTS of the skin are very numerous, and so minute that they cannot be seen with the naked eye; but when these hair-like vessels are injected with quicksilver, (a work of great difficulty,) the surface injected resembles a sheet of silver. In this way their existence can be imperfectly demonstrated. They are also called *lymphatics*, from the Latin, *lympha*, a colorless fluid. They are a part of the

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Give the subdivisions under this head. What is the fifth condition on which the sensibility of the cutaneous nerves depends? Illustrate it. Are the feelings a correct index of warmth or coldness? *What is said of the cutaneous absorbents?* How is their existence proved?

vascular net-work situated upon the upper surface of the true skin. Each papilla is supplied with an absorbent filament, the mouth of which opens beneath, and lies in contact with the under surface of the cuticle. This absorbent net-work communicates through the open meshes of the true skin with larger lymphatic trunks, that open into the venous system.

Fig. 5.

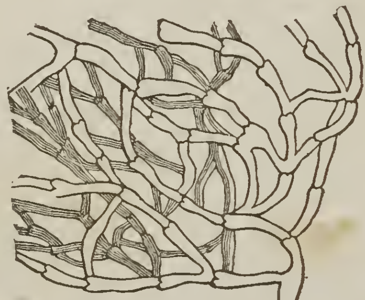

Fig. 5 represents a plexus of *lymphatic* or *absorbent* vessels in the skin, considerably magnified from an injected preparation.

## PHYSIOLOGY OF THE CUTANEOUS ABSORBENTS.

Though some physiologists ascribe but little importance to cutaneous absorption, yet the experiments of Dr. Edwards prove, without a doubt, that when certain conditions of the skin exist, the process of absorption is carried on with great vigor. 1*st. This is most vigorous when the cuticle is removed by vesication or blistering.* Then, external applications are brought in immediate contact with the orifices of these vessels, and by them rapidly imbibed and circulated through the system. Thus arsenic applied to the cutaneous vessels, and strong solutions of opium to extensive burns, have been absorbed in quantities sufficient to poison the patient.

The same results follow if the cuticle is only punctured or abraded. The highly respected Dr. W. of Boston, lost his life by poisonous matter from the body of a patient subjected

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Where are the cutaneous absorbents situated? What does Fig. 5 represent? Give the first condition in which cutaneous absorption is most vigorous. Why? Do the same results follow, if the cuticle is only punctured?

to a post mortem examination. He had removed from his finger, previous to the examination, a 'hang-nail,' and the poison from the dead body was brought in contact with the part denuded of cuticle, and through the agency of the absorbents it was conveyed into the system. Puncture any part of the scarf skin with the finest instrument that has upon its point the smallest conceivable quantity of the *vaccine virus*, or small-pox matter, and it will be brought into contact with the absorbent vessels, and through their agency conveyed into the system. The result is, that persons thus operated upon, have the small-pox, or, the vaccine disease.

In removing the skin from the bodies of animals that have died of disease of any kind, and in handling or managing sick persons or animals, we should see that the cuticle is not broken or otherwise injured; safety and health require this caution. When we expose ourselves to poisonous vapors, we should observe the same caution. It would be beneficial to tanners, curriers, and those who handle substances that may contain poisonous animal matter, to have definite information on this topic. We have known many instances, in which tanners have had introduced into their systems, the poisonous animal matter upon hides, through small ulcers upon their fingers or hands. From these sores there would be seen small red lines, extending up the arm. These swelled tracts indicate an inflammation of the large absorbent trunks, that have been irritated and diseased by the passage of poisonous matter through them into the system.

In case of an accidental wound, it is best immediately to bathe the part thoroughly in pure water, and to avoid all irritating applications. In some instances, it would be well to apply *lunar caustic* immediately. When shrouding dead bodies, or removing the skin from animals that have died of disease, it would be well to lubricate the hands with olive-oil or lard. By so doing the minute portions of the skin, from which the cuticle had been removed, would be protected. In all cases, where there is an ulcer or sore, the part should be covered with something impervious to fluids, as court-plaster, before exposing the system to any animal, vegetable, or mineral poison.

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Relate the case of Dr. W. of Boston. What precaution is necessary in removing the skin from animals that have died of disease? Have persons ever been injured for want of this caution? What directions are given when the cuticle is broken?

In all instances, when any animal, vegetable, or mineral poison has come in contact with the cuticle, broken or unbroken, thorough ablution with soap and water, will remove the oily matter and *poisonous virus* that may have adhered to the skin.

*2d. An inactive state of the lacteals of the digestive organs increases the cutaneous absorption.* This attends two conditions of the digestive organs. 1st. When they are diseased so that food cannot be given with propriety. 2d. When they are healthy, and a due amount of aliment is not taken at proper intervals.

*3d. Moisture and warmth stimulate the absorbents to action.* It is a law of organized bodies, that they act most effectively when excited by an appropriate stimulus. Among the organs of the system, as well as among different individuals, action or effort is induced by different stimulants. Thus one person may be induced to make effort from love of approbation; another, from love of money; a third, from pride. So one set of vessels in the skin is excited to action by the stimulus of blood; another is induced to act by moisture and warmth; a third is excited by a warm and dry state of the skin and air. Let us apply these positions in practice.

Suppose several members of a family are prostrated with a disease that may be communicated from one person to another. It is of importance that those of the family who are in dealth, and others, whom the voice of humanity impels to perform the office of assistants, as watchers or nurses, should be prevented from contracting the disease. Formerly the attendants were excluded from all intercourse with others; alcohol, with decoctions of bitter herbs, was used by them; tobacco was chewed, smoked, and snuffed. But these practices avail but little, as the *virus*, or matter generated in the organs of the diseased person, is conveyed into the system of the attendant, by the action of the absorbents. Narcotising the system with alcohol and tobacco does not diminish the activity of these vessels.

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What should be done immediately when poisons have come in contact with the cuticle? What is the second state upon which the activity of the cutaneous absorbents depends? Upon what two conditions of the digestive organs does this state depend? What law of organized bodies is given? What was the former practice for preventing the system from contracting diseases? Was the former method of narcotising the system of advantage?

If the absorbent vessels are rendered inactive, diseased matter will not be introduced into the system by them, and individuals who note this precaution can enter these rooms with comparative safety. This state of the vessels is induced by observing the following directions. 1st. The stomach should be supplied with *food* of a *nutrient* and *digestible* character, in proper quantities, at proper times, and at stated periods. As the chyle formed from the food stimulates to activity the lacteals of the digestive organs, which activity is attended with an inactive state of the absorbents of the skin and lungs, due attention should be given to the food of the nurses and watchers, and the children in the family.

2d. The skin and apparel should be kept dry. Hence, the necessity of a frequent change of the wearing apparel, and attention to the ventilation of the apartment of the sick. If due attention be not given, the clothing and air of the room will be moistened by the exhalations from the skin and lungs. This exhalation may contain a poison of greater or less power, according to its quantity and degree of concentration, and may be absorbed and re-conveyed into the system, causing inflammatory diseases, and not unfrequently death.

3d. The skin and clothing, and the furniture of the apartment should be cleansed by frequent washing with water and soap. This will remove the poisonous matter that may be deposited upon the skin and garments, which, if suffered to remain, might be conveyed into the system, by the action of the absorbents.

In visiting the unhealthy districts of the South and West, the liability to contract disease is much lessened, by taking a supply of food at proper periods, keeping the skin and clothing in a clean state, the house well ventilated, and avoiding the damp chills of evening.

## ANATOMY OF THE OIL-GLANDS.

The apparatus for keeping the surface of the skin bedewed with an oily fluid, consists of minute tubes, which traverse the cuticle, and enter the substance of the cutis vera, where they terminate in small glands. In some parts they are

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What is a necessary condition of the absorbents to prevent contracting disease? How can this state of the vessels be induced? Why should the skin and apparel be kept dry? Why should they be clean? What precautions are given in removing to climates different from our own? *What is said of the apparatus for keeping the surface of the skin bedewed with an oily fluid?*

wanting; in others, where their office is most needful, they are abundant, as on the face and nose, the head, the ears, &c. In some parts these tubes are spiral, in others straight. These glands offer every shade of complexity, from the simple, straight tube, to a tube divided into numberless ramifications, and constituting a little rounded tree-like mass, of about the size of a millet seed.

In a few situations these small glands are worthy of particular notice, as in the eyelids, where they possess great elegance of distribution and form, and open by minute pores along the lids; in the ear passages, where they produce that amber-colored substance, known as the wax of the ears; and in the scalp, where they resemble small clusters of grapes, and open in pairs into the sheath of the hair, supplying it with a pomatum of Nature's own preparing. These oil-tubes are sometimes called the *sebaceous follicles.*

Fig. 6.

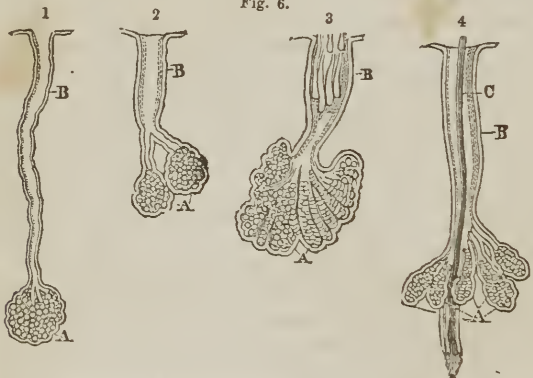


Fig. 6. 1. An oil-tube and gland from the scalp. A, the gland; B, the tube slightly twisted.

2. An oil-tube and gland from the skin of the nose. The gland (A) is double, and communicates with the main tube (B) by means of two smaller tubes. If it be imagined, that the tube (B) is filled with concreted oily substance, the form, size, and situation of the so called "grub" will be understood. The extremity of the tube at the surface of the skin, will become blackened by dust floating in the atmosphere, while the rest retains its natural color.

3. Another oil-tube and gland from the nose. A, the gland; B, the tube filled with the peculiar animalculæ of the oily substance. Their heads are directed inward.

4. A small hair from the scalp, with its oil-glands. The glands (A) form a cluster around the shaft of the hair-tube (C.) These ducts open into the sheath of the hair (B.) All the figures, from 1 to 4, are magnified thirty-eight diameters.

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Do oil-glands exist in every part of the body? Of what form are their tubes? What is said of these tubes in the eyelids? In the ear? In the scalp? What are these glands sometimes called?

## PHYSIOLOGY OF THE OIL-GLANDS.

There is derived from the blood which flows through the capillaries of the oil-glands, *water, salts*, and an *oil* partly free and diffused, and partly mixed with albumen, or white of egg. When the cells are fully formed, that is, fully distended, they yield up their contents, and the fluid matter they contain is set free, and passes along the tubes to the surface; this fluid matter constitutes the oily element of the economy of the skin.

The *animalculæ* of the skin are found in the oil-tubes, whenever there exists any disposition to the unnatural accumulation of their contents. They are found in numbers varying from two to twenty in the interior of the grub-like cylinder.

The uses of the oily or unctuous product of the oil-glands, are two fold. 1st. The *protection*, and 2d. The *defence* of the skin. In the exercise of these offices, the oily substance is diffused over those parts of the skin, which are naturally exposed to vicissitudes of temperature and moisture, — as the nose, face, and head; — to the injurious attrition of contiguous surfaces, — as the flexures of joints; — or the contact of acrid fluids, — as in the excoriations to which infants are liable.

The oil of the unctuous substance is the principal agent in effecting these purposes: 1st. It prevents the evaporation or congelation of the water of the cuticle, which would cause it to become parched and peel off, thus leaving the sensitive skin exposed. 2d. It affords a soft medium to the contact of moving substances. 3d. It repels moisture and fluids. 4th. *The action of these glands purifies the blood in their vital capacity.*

In considering the purpose of the oily or unctuous matter of the skin, there are two situations in which it deserves especial remark. 1. Along the edges of the lids, where it is poured out in considerable quantity. Here, it is the means of confining the tears and moisture of the eyes within the lids, defending the skin from the irritation of that fluid, and preventing the adhesion of the lids, which is liable to occur upon slight inflammation. 2. In the ears, where the unctuous

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Of what is the secretion in the oil-glands composed? Of what use is the oily product of the oil-glands? State the first instance in which it is the principal agent in effecting these purposes. The second instance. The third. What effect has the action of these glands upon the blood? Give the important uses of this secretion along the eyelids. In the ears.

wax not only preserves the membrane of the drum, and the passage of the ear moist, but also, by its bitterness, prevents the intrusion of small insects.

The functional action of the oil-glands is most energetic under the following circumstances: 1st. When the blood of the system is pure. 2d. When the circulation of the capillaries of the skin is active. 3d. When the skin is kept free from *cuticular scales*, *unctuous matter*, and *residual salts*, by frequent ablution, using soap to soften and render miscible in water the oily deposit and exterior face of the cuticle. The retention of these substances upon the cuticle prevents the free escape of the products of the oil-glands, by obstructing the opening of their tubes. But the *long-continued* and *often-repeated* use of strong soaps or alkalies is injurious, as too much of the oily secretion will be removed from the surface of the skin and interior of the oil-tubes, producing the sodden appearance, as seen in the hands of washer-women, which is followed by a parched, peeled, and irritable condition of the cuticle.

Proper, adequate clothing, and systematic ablution with friction, are the appropriate preventives of undue oily accumulation and animalculæ in the oil-tubes. And in instances where such accumulations already exist, these are the most effectual remedial means.

## ANATOMY OF THE PERSPIRATORY GLANDS.

The PERSPIRATORY APPARATUS consists of minute cylindrical tubes, which pass inward, through the cuticle, and terminate in the deeper meshes of the cutis vera. In their course, each little tube forms a beautiful spiral coil; and, on arriving at its destination, coils upon itself in such a way as to constitute a little oval-shaped, or globular ball, called the *perspiratory gland*. The opening of the perspiratory tube on the surface of the cuticle, namely, "the pores," is also deserving of attention. In consequence of its extremity being a section of a spirally-twisted tube, the aperture is oblique in direction, and possesses all the advantages of a valvular

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Under what circumstances are the oil-glands most energetic in their action? What direction in regard to the use of soap? What produces the sodden appearance as seen in the hands of washer-women? What is the remedy for an undue accumulation of oily matter in the oil-glands? *Give the anatomy of the perspiratory glands.* What is peculiar in the opening of this tube on the surface of the cuticle?

opening, preventing the ingress of foreign injurious substances to the interior of the tube and gland.

Fig 7.

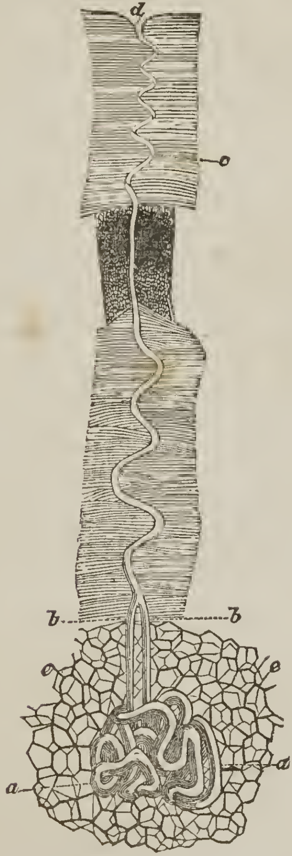


Fig. 7 represents a perspiratory gland from the palm of the hand, magnified forty diameters; *a*, *a*, twisted tube composing the gland; *b*, *b*, two excretory ducts from the gland. These unite to form one spiral tube, that perforates the cuticle (*c*) and opens obliquely on its surface at *d*. The gland is embedded in fat vesicles, which are seen at *e*, *e*.

What does Fig. 7 exhibit?

"To arrive at something like an estimate of the value of the perspiratory system, in relation to the rest of the organism, we counted the perspiratory pores on the palm of the hand, and found 3528 in a square inch. Now each of these pores being the aperture of a little tube about a quarter of an inch long, it follows that in a square inch of skin on the palm of the hand there exists a length of tube equal to 882 inches, or $73\frac{1}{2}$ feet. Surely such an amount of *drainage* as seventy-three feet in every square inch of skin, — assuming this to be the average for the whole body, — is something wonderful; and the thought naturally intrudes itself, What if this *drainage* be obstructed? Could we need a stronger argument for enforcing the necessity of attention to the skin? On the pulps of the fingers, where the ridges of the sensitive layer of the true skin are somewhat finer than in the palm of the hand, the number of pores on a square inch a little exceeded that of the palm; and on the heels, where the ridges are coarser, the number of pores on the square inch was 2268, and the length of the tube 567 inches, or 47 feet. To obtain an estimate of the length of tube of the perspiratory system of the whole surface of the body, I think that 2800 might be taken as a fair average of the number of pores in the square inch, and consequently, 700, the number of inches in length. *Now the number of square inches of surface in a man of ordinary height and bulk is* 2500; *the number of pores, therefore*, 7,000,000, *and the number of inches of perspiratory tube is* 1,750,000, *that is*, 145,833 *feet, or* 48,600 *yards, or nearly* TWENTY-EIGHT *miles!*"* — [Wilson.]

## PHYSIOLOGY OF THE PERSPIRATORY GLANDS.

It is by the agency of the perspiratory and oil-glands that the exhaled matter, which is carried off through the skin, is separated from the blood. This exhalation amounts to a considerable quantity every day. SANCTORIUS experimented upon himself for more than thirty years, weighing himself, his food, and the excretions thrown out, daily. He estimated

* "To the medical reader, it may be necessary to explain, that the sebaceous system, or oil-glands and tubes, is included with the system of perspiratory glands and tubes, in this calculation." — *Wilson.*

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How many perspiratory pores did Prof. Wilson count upon a square inch of skin on the palm of the hand? Give other computations. *Give the physiology of the perspiratory glands.* How is the exhaled matter separated from the blood? Mention the experiment of Sanctorius.

that *five* of every *eight* pounds of food and drink passed from the system through the many outlets upon the skin. Many place the estimate much lower. All physiologists concur that from twenty to forty ounces of matter pass off from the skin of an adult, in the form of insensible perspiration, every twenty-four hours. To prove the existence of this exhalation, take a bell glass, or ipecacuanha vase, and let a hand, perfectly dry, be introduced into it; at the same time close the mouth, by winding a napkin about the wrist; in a short time, the insensible perspiration from the hand will be seen deposited on the inside of the glass. At first, the deposit is in the form of mist; but if the experiment be continued a sufficient time, it will collect in drops. When the circulation of the blood is increased by exercise, or after drinking warm fluids, as tea, it appears in the form of sensible perspiration. This vapor, or perspiration, contains the decayed and useless matter which is carried out of the system by the perspiratory glands. This system of glands is one of the usual channels by which the excess of water is removed from the blood. This excretion, however, contains about one per cent. of solid matter.

The waste material, which proceeds from the bones, muscles, fat, and other parts of the system, is replaced by newly-prepared atoms from the nutrient food. Thus, there is a constant decay and renovation of the system. As an illustration of this, feed two domestic animals with food colored with madder, or any other coloring matter, and on killing one, at the end of four weeks, the bones will exhibit a reddish hue; withdraw the colored food from the other animal a few weeks before killing it, and the bones will be white, — a proof of the ever-changing state of the system.

The appropriate stimulus of these glands should be known, as the health of the system depends on their efficient action. 1st. These glands act with more vigor the first three hours after eating than during the subsequent hours of inanition, showing that the system should be supplied with food in proper quantities and at due intervals. 2d. They are more active during sleep. This points to the necessity of regularity in our hours

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What is the estimate of physiologists of the amount of waste matter which passes from the system every twenty-four hours? How can this be perceived? From what does this waste matter proceed? What is one of the functions of this set of glands? How is the ever-changing state of the system illustrated? Mention the conditions which cause the perspiratory glands to act most efficiently.

of repose, and also thorough ventilation of the bedding every morning. 3d. Dry, porous clothing should be loosely worn, that the serous or watery part of the waste matter may escape freely, and if the saline and animal elements are not removed by frequent bathing and friction, the mouths of the perspiratory ducts will become obstructed.

When the surface of the body is suddenly exposed to cold, or when the chill of fever exists to a considerable degree, the skin will contract very sensibly, and, at the same time, a great number of conical papillæ will project from its surface. This constitutes the *cutis anserina*, or *goose-flesh*, and is supposed to be produced by a sudden contraction of the vessels in the skin, which forces out their contents, and consequently diminishes their bulk, while the papillæ do not contract in the same degree, and are therefore somewhat projected. The perspiratory ducts become contracted when this state of the skin exists; this impedes the vigorous action of the perspiratory glands, and the free escape of perspiration. For this reason, sudden exposures to cold should be carefully avoided.

Not only is the waste matter carried from the system by the perspiratory process, but the *temperature of the system is modified and regulated by the evaporation of fluids from the skin and lungs.* It is well known, that, in the polar regions, and in the torrid zone, under every variety of circumstances, the human body is nearly of the same temperature, however different may be that of the air with which it is surrounded. This is a property peculiar to life, and in consequence of which, even vegetables have a power of modifying, although in a less degree, their own temperature. Without this power of adaptation, it is obvious that man must have been confined for life to the climate which gave him birth, and also have suffered constantly from the change of seasons; whereas, by possessing it, he can retain life in a temperature sufficiently cold to freeze mercury, and sustain, unharmed for a time, a degree of heat more than sufficient to boil water, or even to bake meat. In all ages and climes it has been observed that the increased temperature of the skin and system, in fevers, is abated as soon as free perspiration is restored. In the

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What causes the *cutis anserina*, or goose-flesh? How is the temperature of the system modified and regulated? What is said of the temperature of the human system in various climates? What causes the sensation of coolness in fevers, when perspiration is established?

sultry days of July and August, the disagreeable sensation of heat subsides as soon as the atmosphere becomes clear and dry, or a free perspiration is established, for the reason that heat is abstracted from the system to convert the serous part of the perspiration into vapor.

In warm climates, the skin when in health, is constantly bedewed with perspiration, the evaporation of which reduces the temperature of the system, and produces the grateful sensation of coolness. When free perspiration exists, a corresponding appetite for drink exists, to repair the waste of fluids which attends copious perspiration.

It is frequently noticed, in very warm weather, that dogs and other domestic animals are seen with their tongues lolling out of their mouths, and covered with frothy secretions. This is merely another mode of reducing animal heat, as the skin of such animals does not perspire as much as that of man.

It is on the principle of the evaporation of fluids, that warm vinegar and water applied to the burning, aching head, cools it, and imparts to it a comfortable feeling. The same results follow, if warm liquids are applied to the skin in the hot stage of fever.

When an individual has been thrown into a profuse perspiration, by violent exercise, though the skin and clothing may become wet, he feels no inconvenience from the dampness, as long as he continues that amount of exercise; for the reason, that the circulation of the blood being increased, heat is generated in sufficient quantity to replace the amount abstracted from the system in evaporating the free perspiration; but, as soon as the exercise is discontinued, the increased circulation subsides, and with it the extra amount of generated heat. This accounts for the chill we experience, when the damp clothing is permitted to dry on the body, after the cessation of exercise.

When the clothing has become wet, it is best to change it *immediately*, and to rub the skin with a dry, crash towel, until re-action, indicated by redness, is produced. If the garments are not changed, the exercise should be abated grad-

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Why are we more thirsty in a warm, than in a cold day? What is said of the frothy secretions seen about the mouths of dogs and other animals? Why do warm liquids applied to the skin in fevers, impart a sensation of coolness? How is the chill that we feel after exercise has been discontinued, accounted for? What caution is given respecting wet clothing?

ually, that sufficient heat may continue to be generated in the system to dry the clothing and skin without a chill. Sitting in a cool shade, or current of air, should, by all means, be avoided; as colds are not contracted by free and excessive exercise, but by injudicious management after such exercise.

Between twenty and forty ounces of waste matter pass through the outlets of the skin every twenty-four hours. It is important that this excretion be maintained with steadiness and regularity. When the action of the perspiratory glands is suppressed, all the vessels of the different organs will suffer materially, and become diseased by the redundant waste matter that should be carried from the system. If a person is vigorous, the action of the organs, whose functions are similar to those of the skin, as channels for the exit of waste matter, will be increased, and thus relieve the diseased state of the system. But the over-taxing of these organs to relieve the system, often produces a diseased action in themselves.

Fig. 8.

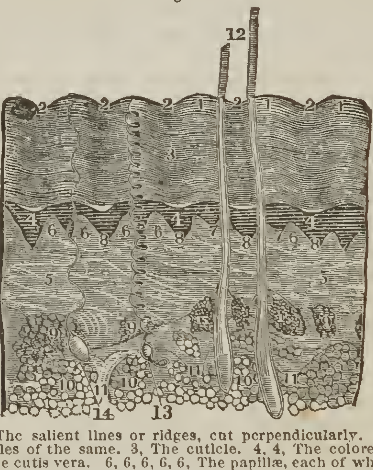


Fig. 8. 1, 1, The salient lines or ridges, cut perpendicularly. 2, 2, 2, 2, 2, The furrows or wrinkles of the same. 3, The cuticle. 4, 4, The colored stratum of the cuticle. 5, 5, The cutis vera. 6, 6, 6, 6, 6, The papillæ, each of which answer to the lines on the external surface of the skin. 7, 7, Small furrows between the papillæ. 8, 8, 8, 8, The deeper furrows between each couple of the papillæ. 9, 9, Cells filled with fat. 10, 10, 10, The adipose layer with numerous fat vesicles. 11, 11, 11, Cellular fibres of the adipose tissue. 12, Two hairs. 13, A perspiratory gland, with its spiral duct. 14, Another perspiratory gland, with a duct less spiral. 15, 15, Oil-glands with ducts opening into the sheath of the hair (12.)

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What of sitting in a shade or current of air? What is the effect when the action of the perspiratory glands is suppressed?

Many cases of chronic coughs, headache, dyspepsia, and diarrhœa, originate in this way. If any one organ of the system has been weakened, this organ is more susceptible of disease than others. If a man is predisposed to stiffness of the joints, and rheumatic pains, a chill will affect these diseased parts. In a person whose lungs are weak or diseased, a chill will immediately cause an irritation, and often inflammation. The same is true of many other diseases.

## PRACTICAL SUGGESTIONS.

To maintain a healthy action of the several tissues and apparatus of the skin, and the different sets of vessels found in them, attention to *exercise, diet, respiration, clothing, bathing, light, and air*, is of great practical importance. The first three will be the topics of investigation in the Chapters on the MUSCULAR, DIGESTIVE and RESPIRATORY SYSTEMS.

The last four will be the topics of the four following sections.

## CLOTHING.

CLOTHING, in itself, does not bestow heat, but is chiefly useful in preventing the escape of heat from the body, and in defending it from the temperature of the atmosphere. In selecting and applying clothing to our persons, the following considerations should be observed.

1*st.* The materials used in the manufacture of apparel should be *be bad conductors of heat*, that is to say, they should have *little tendency to conduct or remove heat from the body;* but on the contrary, they should have the property of retaining what they receive. This depends on the power which the coverings possess of detaining in their meshes atmospheric air.

*Furs* contain a greater amount of air in their meshes, than any other article; they consequently afford the articles of dress best adapted for those who are exposed to the changes of heat and cold.

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What is necessary to maintain a healthy action of the several tissues of the skin? *What is said in respect to clothing?* What is the first condition mentioned? What is said of fur, as an article of clothing?

*Woollen cloth* retains more air in its meshes, than any other article, except furs. Hence, on account of its comparative cheapness, this is the best article of apparel for all classes of persons. Flannels are not only of service during the cold season, in preventing colds, and rheumatism, but they are of great utility in the warm season, in shielding the system from the chills at evening, that induce diarrhœa and dysentery. Hence, their general use among children and delicate females, would be a preventive of the "season complaints" prevalent in the months of August and September.

*Cotton* contains less air in its meshes than woollen, but much more than linen. In texture, it is smoother than wool, and less liable to irritate the skin. In all respects it is well adapted for garments worn next the skin. When woollen flannels irritate the skin, they may be lined with cotton.

*Silk* contains a very considerable amount of air in its meshes; its texture is smooth and does not irritate the skin; consequently, when the garment of this fabric has sufficient body or thickness, it is a good article of clothing.

2*d*. Materials for clothing should be as destitute as possible of the property of *absorbing* and *retaining moisture*, for two reasons. 1st. Moisture renders apparel a good conductor of heat. Hence, damp clothing should never be worn, as it retains less heat than dry. 2d. If the perspired fluid and the saline material it holds in solution, are readily absorbed by the clothing, they become sources of irritation to the skin with which the apparel comes in contact.

*Linen* is not only a good conductor of heat, and consequently a poor article of apparel, but it likewise absorbs the fluids carried from the system by the agency of the oil and perspiratory glands, so that, if the garments are made of this fabric, the body is surrounded by a layer of moisture, in place of an atmosphere of dry air. This still further increases its power to conduct heat from the system, rendering it a very objectionable article of apparel, even in warm weather, and in hot climates, where the dress is usually thin. Cotton and wool do not readily absorb the transpired fluids of the system, and the moisture of the atmosphere; hence, their use is

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Which is next? State the peculiar advantages of wearing flannel, and how it operates on the system. What is said of cotton fabrics? What is said of silk? What is the second observation in regard to the quality of clothing? What is said of linen as an article of apparel?

not so objectionable as linen. The same may be remarked of silk, as of wool and cotton.

3*d*. The skin is not only an important agent in separating from the blood those impurities that otherwise would oppress the system and occasion death, but it exercises great influence in respiration, receiving oxygen through its tissue, and giving back carbonic acid in return. Consequently, the apparel must be such as will permit free transpiration from the skin, and likewise convey the transpired fluids from the surface. Hence, the *clothing should be of a porous character.* The necessity for this is illustrated in wearing India rubber over-shoes. If they are worn ten or twelve hours over boots, not only the hose, but the boots will be moist, from retained perspiration, and the residual matter left in contact with the skin may be reconveyed into the system by the activity of the absorbents, causing headache and other diseases. Cotton and woollen fabrics are not only non-conductors of heat, but are also porous; consequently, they are well adapted to transmit perspiration.

4*th*. The garments should retain a layer of air, kept constantly warm by contact with the body; consequently, they *should be worn loose.* Every one is practically aware that a loose dress is much warmer than one which fits close, — that a loose glove is warmer than a tight one, and that a loose boot or shoe affords greater warmth than one of smaller dimensions. The explanation is obvious; the loose dress encloses a thin layer of air, which the tight dress is incapable of doing, and all that is required, is, that the dress should be closed at the upper part, to prevent the dispersion of the warm air, by the ventilating current which would be established from below. As the purpose of additional layers of dress, is to maintain a series of strata of warm air within our clothes, we should, in going from a warm room into the cold air, put on our defensive coverings some little time previous, in order that the layers of air which we carry with us, may be sufficiently warmed by the heat of the room, and may not borrow from our bodies, which would cause a chill.

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Give the third observation. How is the necessity of wearing porous clothing illustrated? Why should articles of apparel be worn loosely? Why are they warmer? Why should an extra garment be worn in passing from warm rooms to cold air?

*5th.* The clothing should be suited to the temperature of the climate and the condition of the individual. *The rule should always be to wear enough to maintain an equal and healthy action of the skin.* Care should be taken that the action of the cutaneous vessels is not inordinately increased, as this would debilitate not only the skin but the internal organs of the system, as the stomach and lungs. The quantity of clothing demanded by different individuals will vary, consequently no rule as to quantity will apply to all. The following are among the most prominent causes of this variation.

1st. In those persons who have large, active brains, full chests, well-developed lungs, and healthy stomachs, and who take sufficient food to supply the wants of the system, more heat will be generated, and they will require less clothing, than those of an opposite character.

2d. The vital forces of the child being feeble, less heat is generated in its system than in that of an adult, and for this reason it needs the protection of more clothing. The experiments of Dr. Milne Edwards show that the power of producing heat in warm-blooded animals, is at its minimum at birth, and increases successively to adult age; and that young children part with their heat more readily than adults, and, instead of being warmer, are generally a degree or two colder. The system of 'hardening' children, by an inadequate supply of clothing, and keeping them uncomfortably cold throughout the whole day, is inhuman, as well as unprofitable. It operates upon the child somewhat like the long-continued chill upon a certain portion of the farmer's herd, that are kept shivering under the thatched shed, retarding the growth of their systems, which require more food to satisfy the keen cravings of hunger than when they are comfortably sheltered. To make the boy robust and active, he must have nutritious food, at stated hours, and free exercise in the open air, and his system must be guarded from chills by a due amount of apparel.

3d. If the skin be kept clean, by frequent bathing and friction, there will be less clothing needed than when the cutaneous surface is unclean. The film of impurities obstructs

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What is the rule for the amount of apparel that should be worn? What is the effect if too much clothing is worn? Will the same amount of clothing suit every individual? What persons require the least quantity of clothing? Why? Why do children require more clothing than adults? What was proved by the experiments of Dr. Edwards? What is said of the process of hardening children?

the perspiratory ducts, and diminishes the action of their glands; consequently less heat is generated. For this reason the hands or feet are less liable to become chilled or frozen when clean than when otherwise.

4th. If the brain, lungs, or digestive organs are diseased, the generation of heat in the system is diminished. This is observed in headache, consumption, and dyspepsia, which are usually attended with a pale skin and cold extremities. Persons having these complaints, when exposed to cold air, need more clothing than those individuals whose organs are not diseased, and the functions of which are properly performed.

5th. The person of active habits requires less clothing than one of sedentary employments; for exercise increases the circulation of the blood, which is always attended by the disengagement of a greater quantity of heat; consequently, an increase of warmth is felt throughout the system. We likewise need more clothing while riding, than when we are walking; because the exercise of the former is less than that of the latter. The same is true when resting in the field or shop, after laborious exercise; and, for the same reason, we need a greater amount of clothing while asleep, than during the day; as not only the action of the body, but that of the brain, during sleep, is suspended. The practical rule is, *when we cease exercise, or labor, increase the amount of clothing.*

6th. The impressibility or sensitiveness of the skin to the influence of cold, is much modified by *habit.* A person who has been habituated to the temperature of a warm room, or warm climate, suffers more when exposed to cold, than an individual who has been accustomed to colder air. Thus a person who labors or studies in a warm room, should wear more clothing when exposed to the air, while walking or riding, than an individual who labors in a cooler atmosphere. Not only is the impressibility of the skin increased by a warm atmosphere, but the activity of the digestive, respiratory, and nervous systems, in generating heat, is much diminished. This is an additional reason why an increased amount of

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When the hands and feet are to be exposed to a colder temperature, what should be their state in regard to cleanliness? Why? Name other causes for the variation of heat. Why do students and others of sedentary employments require more clothing than those of active habits? Why do we need a greater amount of clothing while asleep than when awake? Does habit modify the sensitiveness of the skin? What caution should be adopted under such circumstances?

clothing is demanded during exposure. In all cases where practicable, the heat of the system should be maintained by *exercise*, in preference to the use of fur or flannel.

7th. More clothing is required in the evening than during the day. In the evening we have less vital energy, the atmosphere is damp, and the skin has become moist from free perspiration. For these reasons, we should be provided with an extra garment, to be worn when returning from crowded assemblies. The skin is then not only more moist by the dampness of the air in the crowded apartments, and by perspiration, but it is rendered more sensitive. If there be a chill upon the system after having arrived home, warmth should be restored as speedily as possible. This can be done by friction with warm flannels, and by using the warm or vapor bath. By this procedure the pernicious effects of the chill will be prevented before any disease is fixed upon the system. Is it not the duty of the parent, the guardian, and the teacher, to learn these facts, and to see that these rules are not only learned, but reduced to practice? The farmer and industrious mechanic would be freed from many a rheumatic pain, if, while resting from their labors at evening, or taking the ordinary meal, after hard toil, they would put on an extra garment. The coat might not feel so agreeable for the first few minutes, but it would ultimately conduce to comfort and the continuance of health.

Our next inquiry is relative to the change of clothing. This embraces two points: — 1st. No article of apparel is entirely free from absorption; even wool and cotton possess it to a considerable degree. They take up a portion of the transpired fluids which contain saline and animal matter. The fibres of the garments become imbued and covered with the cutaneous excretions. This diminishes the porosity of the clothing, and its power of conducting heat from the system, while the residual matter with which the clothing is coated is brought in contact with the skin, causing irritation of its surface and re-absorption of the elements thrown off from the system through this avenue. Hence, *warmth*, *health*, and *cleanliness* require that the clothing, particularly the garments

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When do we need the most clothing? Why? In case of a chill, what should be done? Can all these principles be reduced to practice? Should they be? Give the first remark upon the necessity of changing the clothing. What is requisite to promote health, cleanliness and warmth of the body?

worn next the skin, be frequently and thoroughly washed. This should not be forgotten in regard to children, for their blood circulating with greater rapidity than that of adults, a proportionably greater amount of waste matter is thrown off from their systems.

As the bedding, after the bed has been occupied, becomes imbued with the materials eliminated from the skin of the occupant, (and these excretions are most abundant during the hours of sleep,) it should be removed and washed, or well aired, by being thrown over chairs for some hours, with the doors and windows open. If this is not done, the moist bedding will cause a chill or "cold" to the system of the next occupant, and the waste matter with which the bedding is imbued, will be carried into the system by the action of the absorbents. Oftentimes diseases of a disagreeable nature are contracted in this way. This fact should be instilled into each mother's and daughter's mind.

2d. When changes of dress, from thick to thin, are necessary, they should always be made in the morning, when the vital powers are in full play. Many a young lady has laid the foundation of a fatal disease, by disregarding this rule, in exchanging the thick, home dress, with woollen stockings, for the flimsy dress, and hose of silk or cotton, which are considered suitable for the ball-room or party. The disregard of nature's law, already adverted to, is a very common source of disease. Sudden changes in wearing apparel, as well as in food and general habits, are attended with hazard; and this is proportionate to the weakness or exhaustion of the system when the change is made.

## BATHING.

The structure and purposes of the skin, the constant removal and reproduction of the cuticle, the functions of the oil-glands and perspiratory system, afford the groundwork for inferring the necessity of bathing. The cuticle is cast off in minute, powdery scales, many of which are retained upon the surface by the pressure of clothing. These mingle with the oily and saline products of the skin, and form a thin crust.

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Give the reason why a bed should not be made as soon as the occupant leaves it. What is said of exchange of dress from thick to thin? What is a very common source of disease? *Give the reasons for bathing.*

This crust, on account of its adhesiveness, collects particles of dust and soot from the atmosphere, and particles of foreign matter from our dress, so that in the course of the day, the whole body becomes coated with impurities. If this coating be allowed to remain, to become thick and established upon the skin, it will produce the following effects: 1st. The pores will be obstructed, consequently transpiration impeded, and the influence of the skin as a respiratory organ, entirely prevented. When the pores are obstructed, and transpiration is checked, the elements of the transpired fluids will necessarily be thrown upon the system; and, as they are injurious and poisonous if retained, they must be removed by other organs than the skin. These organs are the *lungs*, *kidneys*, *liver*, and *intestines*. When these organs are called upon to perform their offices, and in addition that of another, the healthy equilibrium is destroyed, and the oppressed organ will suffer from exhaustion, and become the prey of disease. Thus, obviously, habits of uncleanliness are the cause of consumption and other serious diseases of the vital organs. Again; obstruction of the pores will prevent respiration through the skin, thus depriving the blood of one source of its oxygen, and one outlet for its carbonic acid, which will diminish the temperature of the system, and all the effects of chill, from inadequate clothing, will be manifested.

2d. The retained film will irritate the skin, both mechanically and chemically; it will keep it damp and cold, from attraction and detention of moisture; and, possibly, foreign matters, once removed from the system, may be re-conveyed into it by absorption. As a consequence, cutaneous eruptions and diseases will be produced, and the re-absorption of matter once separated from the system, will be the exciting cause of other injurious disorders.

3d. A film of foreign substance on the skin will inevitably become the seat of detention of miasmata and infectious vapors, which will rest here previously to being absorbed, and their absorption will engender the diseases of which they are the peculiar cause. These are the most serious results of uncleanliness of the skin.

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What is the consequence of not removing impurities from the skin? How does checked transpiration produce pulmonary and liver complaints? Give another reason why the skin should be bathed frequently. What is one source of cutaneous eruptions? Give a third reason for frequent bathing

Baths are useful for three purposes: 1. To promote cleanliness. 2. To preserve health. 3. To remove disease. In its first capacity, bathing enables us to remove the coating of impurities from our bodies. It effects this purpose by dissolving saline matters, and holding in temporary suspension those substances which are insoluble. These substances are of an oily nature, and the skin being provided with an oily secretion, soap renders the oily product of the skin miscible in water; hence it is an invaluable agent for purifying the skin. It is an indispensable aid, for in no other way can the substance upon the surface of the skin, and the impurities which adhere to it, be thoroughly removed. If any unpleasant sensations are felt after the use of soap, they may be immediately removed by washing the surface with water slightly acidulated with lemon-juice or vinegar.

Bathing may be partial or general, and the water used may be cold, temperate, tepid, warm, or hot. A person may apply it to his system with a sponge, it may be poured upon him, or he may immerse himself in it. The simplest mode of bathing is to apply water to a small extent of surface, by means of a wetted sponge, and after being wiped dry, again cover with the dress. In this way the whole body may be speedily subjected to the influence of water, and to no less useful friction. The water used may be warm or cold. This species of bathing may be practised by any invalid, and always with benefit, if the bathing is succeeded by a glow of warmth over the surface, as this is the test by which the benefit of all forms of bathing is to be estimated.

The bather may stand or sit in a shallow tub, while he receives the water from a sponge squeezed over the shoulders or against the body. In this form of bathing the person is more exposed; hence it is less suitable for very feeble individuals than the first-named method. In the early use of this form of the sponging bath the bather should content himself with a single effusion from the sponge, and should then dry the body quickly with brisk rubbing.

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For how many purposes are baths useful? What are they? How is bathing effectual in its first capacity? Why should soap be moderately used in bathing? If unpleasant sensations are felt from the free use of soap, how can they be counteracted? How may bathing be effected? Give the simplest mode. Can this mode be adopted by invalids with safety? What is the test, in all modes of bathing, whether it is beneficial?

The third kind of bathing is that of the shower-bath, which provides a greater amount of affusion than the former, combined with a greater shock to the nervous system. The concussion on the skin by the fall of water, particularly distinguishes this from the previous modes of bathing. The degree of concussion is modified by the size of the openings through which the water issues, and the height of the reservoir. The shower-bath admits of modification, adapting it to the most delicate as well as the robust. The extent of fall, the size of the apertures, the quantity and temperature of the water, may be regulated at pleasure. In using the shower-bath it would be judicious to commence with warm water, for which, by a gradual process, cold water may be substituted. In this way the system may be inured to cold water. After bathing the skin should be wiped dry and rubbed briskly.

The fourth form of bathing is that in which the body, or a portion of it, is immersed in water. The temperature of the water in this form of bathing, may be modified according to the sensations and purposes of the bather. This form of bathing is designated according to the heat of the water. When the temperature is below 75° it is termed a cold bath; when from 75° to 85° a temperate bath; from 85° to 95° a tepid bath; from 95° to 98° a warm bath; from 98° to 105° a hot bath. In using this form of bathing the skin should be wiped perfectly dry, and briskly rubbed. The length of time a person may remain in a cold bath with benefit, varies from two to ten minutes, while a person may remain in a temperate, tepid, or warm bath from ten to thirty minutes, or until special indications are exhibited.

In the *vapor-bath* the vapor is not only applied to the exterior of the system, but it is inhaled and brought in contact with every part of the interior of the lungs. The bather is seated upon a chair, and the vapor gradually turned on around him, until the proper temperature (90° to 110°) is attained. In this form of bathing, the skin should be wiped dry, and smartly rubbed. The bath may be continued from ten to thirty minutes.

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What is said of the shower-bath? What caution is given? Give the fourth form of bathing. What degree of temperature of water is termed a cold bath? A temperate? A tepid? A warm? A hot bath? Give the length of time that a person should remain in the different baths. What is said of the vapor-bath?

In order to increase and promote the reaction of the skin, various measures and processes are used, some of which are practised in, and others after quitting the bath. Of the former, the rubbing and brushing the skin are the most common and important. The brisk and efficient friction of the skin with a coarse towel and flesh-brush, after quitting the bath, should never be omitted. This short catalogue embraces all the appliances requisite for the purpose.

Bathing, in its second capacity, preserves and promotes health by its immediate and remote physiological effects on the system. When the body is moistened with a sponge wetted with cold water, or when affusion by the sponge or shower-bath is effected, the skin instantly shrinks, and the whole of its tissue contracts. This contraction diminishes the capacity of the cutaneous system of blood-vessels, and a portion of the blood circulating through them is suddenly thrown upon the deeper parts and internal organs. The nervous system, among others, participates in it, and is stimulated by the afflux, and communicates its impression of stimulus to the whole system. This causes a more energetic action of the heart and blood-vessels, and a consequent rush of blood back to the skin. This is the state termed *reaction*, the first object and purpose of every form of bathing whatever. It is the test of its utility and safety. This reaction is known by the redness of the surface, the glow, comfort, and warmth which follow the bath. The bather should direct all his care to ensure this effect. By it the internal organs are relieved, respiration is lightened, the heart is made to beat calm and free, the mind is clear and strong, the tone of the muscular system is increased, the appetite is sharpened, and the whole system feels invigorated. This is the end and aim of the bather, and to this all his training tends. The error is, to expect the result without the preparation.

In order to promote this reaction, and to be efficient in preserving health, bathing should be regular, should be commenced by degrees, and increased by a process of training, and should not be permitted to intrude upon hours devoted to some important function, as digestion. It must not precede or follow too closely a meal or severe mental or muscular exer-

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Give the different methods for promoting reaction of the skin. Show how bathing preserves and promotes health How should bathing be practised, and when?

cise, as reaction is less certain and vigorous, when important internal organs are employed, than when they are at rest. When the vital powers are greatest, and the system most free from exhaustion, bathing is most beneficial; hence, the morning is preferable to the evening, and the middle of the forenoon to the middle of the afternoon, for this healthful and agreeable duty; as the vital action of the system is most energetic in the early part of the day.

As regards the frequency of bathing, the face and neck, — from their necessary exposure to the atmosphere, and the impurities which the latter contains, — should receive at least two washings in twenty-four hours, one of which should be with soap; the feet, from the confined nature of the coverings which are worn over them, require at least one; the armpits, from the detention, as well as from the peculiar properties of the secretions, at least one; and the hands and arms, as many as seem proper. The whole person should be bathed every second day, without fail, and every day if possible.

In diseases of the skin and internal organs, bathing is a remedial measure of great power. It should never be neglected or omitted. It is not only pleasant and safe, but is really more effective than any medicine administered internally. This, like other curative means, should be applied by the direction and under the eye of the medical adviser, that it may be adapted to the condition of the patient.

"From the first hour of man's existence to his latest breath, in health and in sickness, rich or poor, water is always requisite. Baths were dedicated by the ancients to the divinities of medicine, strength, and wisdom, namely, Æsculapius, Hercules, and Minerva, to whom might properly be added the goddess of health, Hygeia. The use of water has been enforced as a religious observance, and water has been adopted as one of the symbols of Christianity."

## AIR.

As the waste material, which is carried from the system in the form of perspiration, is removed from the skin by being diffused through the atmosphere, it is of much importance that

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How often should the entire surface of the skin be washed? In disease, should bathing be neglected? Who should direct the kind of bath proper in different diseases? *Why should the surrounding air be pure?*

the surrounding air be pure. In the sultry mornings of July and August, the air is loaded with moisture and impurities, and the perspirable matter is not removed from the system as it is when the air is pure and dry. This is the cause of the general lassitude that is experienced during such mornings. As soon as the fog is dispelled, these unpleasant sensations are removed.

To sustain the functions of the skin in a healthy state, the parlor, kitchen, sleeping-room, school-house, and work-shop, should be well ventilated. The blood of the system will be purer, and its color of a brighter scarlet, if the skin be kept clean by bathing, warm by proper clothing, and surrounded by fresh and pure air.

## LIGHT.

It is observed by all, that solar light exercises much influence upon the vigor and color of vegetables. Plants that are kept in well-lighted rooms, have darker and more brilliant colors than those that grow in darkened apartments. Light exercises a similar influence on men and animals. Thus we see that those individuals who labor in low, damp, dark rooms, are pale and sickly. The light permeating the skin, not only exercises a salutary influcnce upon its tissue, but upon the blood, and through this fluid, upon the whole system. This established fact shows how important it is that school-houses, mechanics' shops, kitchens, and sitting-rooms, be not only well ventilated, but favorably situated to receive light. For the same reasons, the kitchen and the sitting-room, which are the apartments most used by ladies, should be selected from the most pleasant and well-lighted rooms in the house. Dark rooms and damp cellar-kitchens should be avoided, as exercising an injurious influence upon both body and mind. The dark, damp rooms, so much used in cities and large villages, by indigent families and domestics, are fruitful causes of disease, as well as of vice, poverty, and suffering.

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What is the cause of the lassitude we feel during sultry weather? What is necessary to sustain the functions of the skin in a healthy state? *What is said of the effect of light on the skin?* What is one cause of disease and suffering in large villages? To what does this point?

## APPENDAGES TO THE SKIN.

The HAIRS are appendages to the skin. They have no blood-vessels or nerves, and consequently no vitality. They are a product of secretion. The hair takes its origin from the cellular membrane, in the form of bulbs. In texture, it is dense, and homogeneous towards the circumference, and porous and cellular in the centre, like the pith of a plant. Every hair has on its surface pointed barbs, arranged in a spiral manner, and directed towards the root of the hair; so that if a hair be rolled between the fingers, it moves only in one direction. The color of the hair varies in different individuals, and is generally supposed to depend on the fluids contained in the pith. In several instances, it has been known to change from black to gray in the course of a single night, from the effect of grief, or some other great mental agitation.

There are two causes which act in changing the hair gray. The first is, defective secretion of the coloring fluid. The second is, the canals, which convey the fluid into the hair, become obliterated. In the first instance, the hair will remain; in the second, it dies, and drops out. Each hair is enclosed beneath the surface by a vascular secretory follicle, which regulates its form during growth.

Fig. 9.

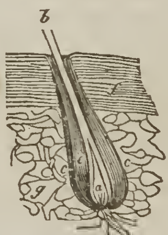


Fig. 9. The hair follicle (*e*) is represented as embedded in the cellular membrane, (*g*,) which is situated beneath the skin; *c*, *c*, the membraneous sac, which has a narrow neck, opening externally by a contracted orifice, through which the hair (*b*) passes. Its internal surface is smooth, and not adherent to the hair, but separated from it by a reddish fluid. From the bottom of the sac, at *a*, the pulp of the hair arises. The hair passes through the skin at *f*.

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*What are the hairs?* Describe them. Upon what does the color of the hair depend? What are the causes of the hair becoming gray? What is the cause of the hair dropping out? How is each hair enclosed beneath the surface of the skin?

In those parts of the system that are naturally clothed with hair, as the upper part of the head, the oil-tubes open into the hair-sacs; consequently, the secretion of the oil-glands is spread over the surface of the hair, and not upon the cuticle. This is the reason of the dry, white, branny scales, called "scurf," upon the head. This is natural, and cannot be prevented. All the treatment demanded when scurf exists, is the frequent use of the hair-brush, and washing with pure water. Soap should not be used in washing the head.

The NAILS are hard, elastic, flexible, semi-transparent scales, and present the appearance of a lamina of horn. The nail is divided into the *root*, the *body*, and the *free portion*. The root is that part which is covered on both surfaces; the body is that portion which has one surface free; the free portion projects beyond the end of the finger.

The nail is formed of several laminæ, or plates, that are fitted the one to the other; the deepest is that which is last formed. The nails, like the hoofs of animals, and the cuticle, are products of secretion. They receive no blood-vessels or nerves. If the cuticle be removed in severe scalds, they will separate with it, as the hoofs of animals are removed by the agency of hot water. The nails increase in length and thickness, by the deposition of albumen upon their under surface, and at their roots, in a manner similar to the growth of the cuticular membrane, of which they constitute a part.

Fig. 10.

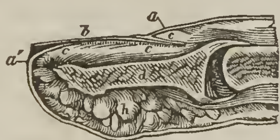


Fig. 10 represents a section of the end of the finger and nail. *d*, section of the last bone of the finger; *h*, fat, forming the cushion at the end of the finger; *b*, the nail; *a*, *a*, the cuticle continued under and around the root of the nail, at *c*, *c*, *c*.

The nails, from their position, are continually receiving knocks, which produce a momentary disturbance of their cell formation, followed by a white spot. The care of the nails

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What occasions scurf upon the head? What should be the treatment where it exists? *Describe the nails.* How should the nails be treated, to prevent irregularities and disease?

should be strictly limited to the knife or scissors, to their free border, and an ivory presser, to prevent adhesion of the free margin of the scarf-skin to the surface of the nail. This edge of the cuticle should never be pared, the surface of the nail never scraped, nor the nails cleaned with any instrument whatever, except the nail-brush, aided by water and soap. The observance of these directions will prevent their irregularities and disorders.

## CELLULAR TISSUE.

Fig. 11.

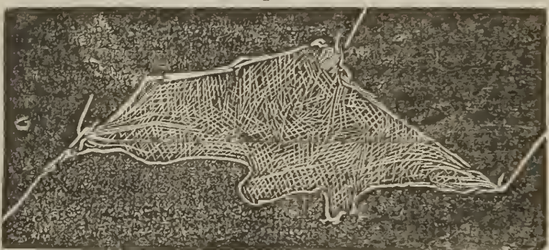

Fig. 11 represents a single film of the cellular membrane raised and slightly distended.

The cellular membrane, considered by anatomists as the primary tissue, is formed of innumerable small fibres, of every variety of shape and size, running in every possible direction, forming a reticulated or net-like arrangement. In some situations, these fibres are narrow, loose, and comparatively distant. In others, they are broad and close, so as to form partial cells, which communicate with each other. To prevent the cells of this net-work from adhering, a fluid, formed from the blood-vessels, or the membrane itself, is secreted or thrown out, which keeps them always moist. When this fluid becomes too great in quantity, in consequence of disease, the patient labors under general dropsy. The swelling of the feet when standing, and their return to a proper shape during the night, so often noticed in feeble persons, furnishes a striking proof both of the existence and peculiarity of this membrane, which

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Describe Fig. 11. *What is the cellular tissue considered to be by some physiologists?* Describe it. What striking proof of the existence and peculiarity of this membrane?

allows the fluid to flow from cell to cell, until it settles in the lowest part.

One remarkable circumstance connected with this tissue is, that it exists throughout the body, and is every where accessible to air. This is shown by forcing air into its cells in any part of the system. It will permeate and penetrate every part, until the whole body is inflated. Butchers often avail themselves of a knowledge of this fact, and inflate their meat to give it a fat appearance.

Although this tissue enters into the composition of all organs, it never loses its own structure, nor participates in the functions of the organ of which it forms a part. Though present in the nerves, it does not share in their sensibility; and though it accompanies every muscle and every muscular fibre, it does not partake of the irritability which belongs to those organs.

## ADIPOSE TISSUE.

This substance, commonly called fat, is deposited in distinct bags or cells, that are seen in the loose cellular membrane. The annexed figure gives a representation of the adipose tissue.

Fig. 12.

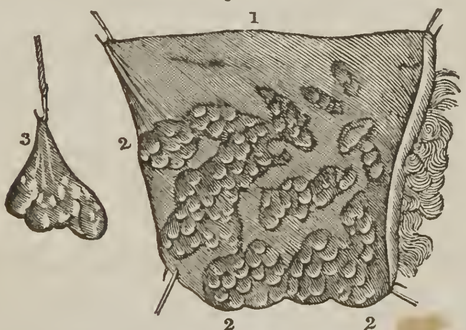


Fig. 12. 1, A portion of the adipose membrane. 2, Minute bags containing fat. 3, A cluster of these bags, separated and suspended.

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What remarkable circumstance is connected with the cellular membrane? Where is the cellular tissue found? What use do butchers make of a knowledge of this tissue? Has it sensibility? *Describe the adipose tissue.* What does Fig. 12 represent?

In those individuals who are corpulent, there is, in many instances, a great deposit of this substance. As this accumulates more readily than other tissues when a person becomes gross, so it is earliest removed when the system emaciates, in acute or chronic diseases. In some instances, some of the masses, called *pelitongs*, which compose this tissue, become enlarged. These enlargements are called *adipose tumors*.

Adipose tissue is principally, found beneath the skin, abdominal muscles, and around the heart and kidneys; while none is found in the cranium, brain, eye, ear, nose, and several other organs.

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Does the adipose tissue accumulate readily? Do these masses ever enlarge? What are they called? Where is the adipose tissue mostly found? Where is it never found?

# CHAPTER III.

## ANATOMY OF THE BONES.

In the mechanism of man, the variety of movements he is called to perform, requires a correspondent variety of component parts, and the different bones of the system are so admirably fitted to each other, that they admit of this extent of motion.

When the bones composing the skeleton are united by natural ligaments, they form what is called a *natural skeleton;* when united by wires, what is termed an *artificial skeleton.*

The protuberances of the bones are termed *processes*, and are, generally, the points of attachment for the muscles and ligaments.

### ANATOMY OF THE BONES OF THE HEAD.

The HEAD is divided into the *cranium* and the *face.* The bones of the cranium are eight in number. They are formed of two laminæ, or tablets of bony matter, united by a spongy or porous portion of bone. The relation of the two tablets and spongy portion is represented in the annexed engraving.

Fig. 13.

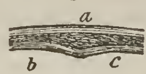


Fig. 13. *a*, The external bone; *b*, *c*, the internal table. The intervening cellular texture is spongy, and conveys vessels and nerves from one part to another.

The external lamina is fibrous and tough; the internal plate is dense and hard, and is called the *vitreous*, or *glassy table.* These tough, hard laminæ are calculated to resist the pene-

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Is there an adaptation of the bones of the system to the offices they are required to perform? What is a natural skeleton? What an artificial? Of what use are the processes? *How are the bones of the head divided?* How are the bones of the cranium formed? Describe the external tablet. The internal.

tration of sharp instruments, while the different degrees of density possessed by the two tablets, and the intervening spongy bone, are calculated to diminish the vibrations that would occur in falls or blows.

All the bones of the cranium are united by ragged edges, called *sutures*, from *suo*, I stitch. When one seam overlaps the other, it is called a *false suture*. All true sutures are zigzag lines, as seen in fig. 14.

The sutures interrupt, in a measure, the vibrations produced by external blows, and also prevent fractures from extending as far as they otherwise would, in one continued bone.

Fig. 14.


Fig. 14. *a*, *a*, The coronal suture at the front and upper part of the head; *b*, the sagittal suture that lies upon the top of the head; *c*, *c*, the lamdoidal suture at the back part of the head; *d*, *d*, the *ossa triquetra*, small ragged bones, occasionally found in some skulls, lying in the last-mentioned suture; *e*, *e*, partitions of the temporal bone.

From infancy to the tenth or twelfth year, the sutures are imperfect; but from that time to thirty-five or forty, they are distinctly marked; in old age they are nearly obliterated.

Blows should by no means be given on the head of children, either with the hand or by a stick, as the entire character and destiny of a child may be altered by a blow on the half-formed skull.

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How are the bones of the cranium united? What kind of lines have true sutures? What are the uses of the sutures? What is said of the ossa triquetra? What of the changes of the sutures? Should blows be given on the head?

The skull is convex externally, and at the bottom much thicker than at the top or sides. The most important part of the brain is placed here, completely out of the way of injury, unless of a very serious nature. The bottom of the cranium has many projections, depressions, and holes; the latter affording passages for the nerves and blood-vessels.

Fig. 15.

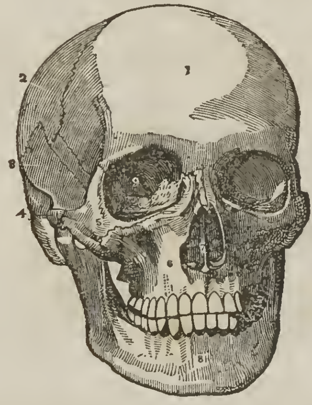

Fig. 15. 1, Bone of the forehead, called the frontal. 2, The parietal bone. 3, The temporal bone. 4, The zygomatic process of the temporal bone. 5, The malar or cheek bone. 6, The upper jaw bone. 7, The vomer that separates the cavities of the nose. 8, The lower jaw. 9, The cavity for the eye.

We find as great a diversity in the form and texture of the skull bone, as in the expression of the face. The head of the New Hollander is small; the African has a compressed skull; while the Caucasian is distinguished by the beautiful, oval form of the head. The Greek skulls, in texture, are close and fine, while the Swiss are softer and more open.

There are fourteen bones in the face, some of which serve for the attachment of powerful muscles, which are more or less concerned in masticating food; others retain in place the soft parts of the face.

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What is the form of the skull? How does the base of the skull compare in thickness with the top and sides? Is there, in different nations, a diversity as to the form and texture of skull bones? Give some instances. How many bones are there in the face? Their use?

The TEETH are inserted in the sockets of the upper and lower jaw. Generally, each tooth is divided into two parts; one situated without, called the *crown;* the other buried in the socket, and terminated by one or more points, called the *root* of the tooth. Between the crown and the root a slight shrinking is often remarked; this is called the *neck* of the tooth

Fig. 16.


Fig. 16. This view will display to the pupil the more important parts of the base of the skull. 1, The occipital bone. 2, 2, The parietal bones. 3, 3, The temporal bones. 4, A hole formed by the union of a projection from the temporal bone, with a projection from the upper jaw. 5, The bony plate which forms the roof of the mouth. 6, Small pyramidal projections from the temporal bones. 7, 7, The condyles that unite the skull and spine. 8, Spinal hole, through which the spinal cord passes. 9, 9, The depressions into which the lower jaw fits.

The teeth are the only bones in the human frame which are exposed to the immediate action of foreign substances. To prevent them from being corroded, they are covered with *enamel*, from which they derive security as well as beauty.

The teeth are formed in the interior of the jaws, and within little membranous pouches, called *dental capsules*, which are enclosed within the substance of the bone, and present in their interior a fleshy bud, or granule, from the surface of which exudes the stony matter, called ivory, of which the tooth is composed.

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Where are the teeth inserted? Into what parts is a tooth divided? Describe Fig. 16. What prevents the teeth from being corroded? How are the teeth formed?

In proportion as the tooth is formed, it rises in the socket, passes through the gum, and shows itself without. The enamel is found at the superior portion of the dental capsule, and covers the tooth just to the extent it traverses that part of the socket ; for this reason the root, which remains in the socket, is not covered by enamel.

Fig. 17.

Fig. 17. 1, The body of the lower jaw. 2, Ramus, to which the muscles which move the jaw are attached. 3, 3, The condyles which unite the upper jaw with the head. *i*, The middle and lateral incisor tooth of one side ; *b*, the biscuspid teeth ; *c*, the cuspides, or eye teeth ; *m*, the three molar teeth. A, shows the relation of the permanent to the deciduous or temporary teeth.

The teeth which are formed in the earliest period of life, are called *temporary*, or *milk teeth.* They number twenty. The *permanent* teeth are more firmly fixed in the jaw, and number thirty-two ; eight *incisors*, because they serve to cut the food ; four *cuspids*, or *canine teeth*, two of which, in the upper jaw, are called *eye teeth ;* eight *bicuspids*, so called because they terminate in two points ; eight *molars*, or *grinders ;* four *wisdom teeth*, so called because they do not usually appear until the individual has arrived at mature age.

The temporary teeth in children should be removed as soon as they become loose, for the reason that the permanent teeth are forming in the sockets of the jaw, (see A, fig. 17,) and, if their egress is impeded, they will present, in manhood, a crowded or irregular appearance.

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When does the tooth rise in the socket? Where is the enamel formed? Why is there no enamel on the roots of the teeth? Describe Fig. 17. What are those teeth called that are formed in infancy? Their number? Those in childhood? Their number, and how divided? Why should attention be given to the removal of the milk or temporary teeth?

Fig. 18.

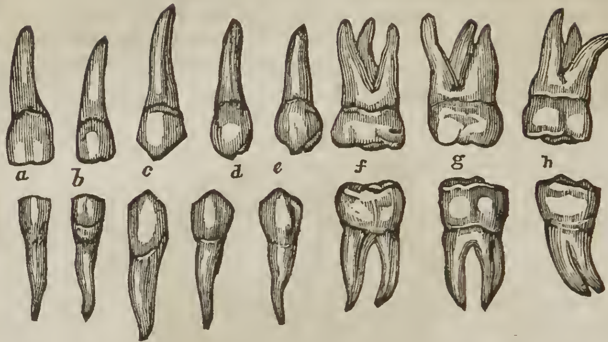


Fig. 18. The permanent teeth of the upper and lower jaw. *a*, central incisors; *b*, lateral incisors; *c*, cuspids, or canine teeth; *d*, the first bicuspids; *e*, second bicuspids; *f*, first molars; *g*, second molars; *h*, third molars, or *dens sapientiæ.*

In the tongue there is one bone, named the *os hyoides.* It is shaped like the letter U, and situated at the under and back part of the lower jaw, and above the prominence of the throat.

Fig. 19.

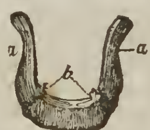


Fig. 19. *a*, *a*, The great cornua; *b*, the small cornua of the os hyoides.

## BONES OF THE TRUNK.

The TRUNK contains fifty-four bones. They are so arranged as to form, with the soft parts attached to them, two cavities, named the *thorax*, or *chest*, and the *abdomen*.

The THORAX is formed of the sternum in front; the ribs at the sides; and the twelve dorsal vertebræ of the spinal

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What is the name of the bone of the tongue? Where is it situated? *How many bones are there in the trunk?* What do they form? Describe the thorax, or chest.

column posteriorly. The natural form of the chest is a cone, with its apex above, but fashion, in many instances, has nearly inverted this order. This cavity contains the lungs, heart, and large blood vessels.

Fig. 20.

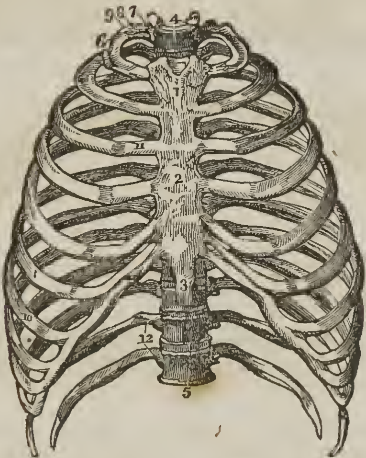


Fig. 20. 1, The first bone of the sternum. 2, The second bone of the sternum. 3, The ensiform cartilage of the sternum. 4, The first dorsal vertebra. 5, The last dorsal vertebra. 6, The first rib. 7, Its head. 8, Its neck. 9, Its tubercle. 10, The seventh, or last true rib. 11, The cartilage of the third rib. 12, The false or floating ribs.

The STERNUM, sometimes called the breast bone, is composed of eight pieces in the child. These unite and form but three parts in the adult. In youth the two upper portions are converted into bone, while the lower portion remains cartilaginous and flexible until extreme old age.

The RIBS are twenty-four in number; twelve on each side. The seven upper ones are united to the sternum, through the medium of cartilages, and are called the *true ribs*. The cartilages of the three lower ribs are united with each other, and are not attached to the sternum; these are called *false ribs;* the lowest two are called floating ribs, as they are not con-

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Describe the sternum. How many ribs are there? How are the seven upper ribs united? The five lower ribs?

nected either with the sternum or the other ribs. All the ribs are connected with the spinal column, and increase in length as far as the seventh. From this, they successively become shorter. The direction of the ribs from above, downward, is oblique, and their curve diminishes from the first to the twelfth. The inferior, or lower ribs, are very flat. The external surface of each rib is convex; the internal, concave.

Fig. 21.

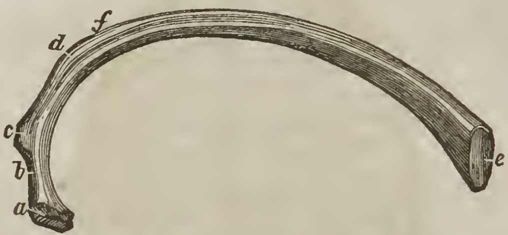


Fig. 21. A representation of the fourth rib; *a*, vertebrated extremity, called the dorsal, which is connected with two of the vertebræ; at *b*, the bone is contracted, forming the neck; *c*, the tubercle at the back of the rib, which is articulated with the transverse process of the vertebra; *d*, the angle; *e*, the sternal extremity; *f*, a groove for the internal vessels.

The SPINE contains twenty-four bones, or vertebræ. On examining one of the bones, we find seven projections, named *processes;* four of these, that are employed in binding the bones together, are called articulating processes; two of the remaining are called the transverse; and the other, the spinous. The latter gives attachment to the muscles of the back. The large part of the vertebra, called the body, is round and spongy in its texture, like the extremity of the round bones. The processes are of a more dense character. The projections are so arranged that a tube or canal is formed immediately behind the bodies of the vertebræ, in which is placed the *medulla spinalis*, or spinal cord, sometimes called the pith of the back bone.

Between these joints or vertebræ, is a peculiar and highly elastic substance, which much facilitates the bending movements of the back. This yielding cushion of cartilage also

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How do they increase in length? How many bones in the spine? What is another name for these bones? How many processes have they? Which process gives attachment to the muscles of the back? Where is the spinal cord situated? What is placed between each vertebræ? What is its use?

serves the important purpose of diffusing and diminishing the shock in walking, or leaping, and tends to protect the delicate texture of the brain.

Fig. 22.

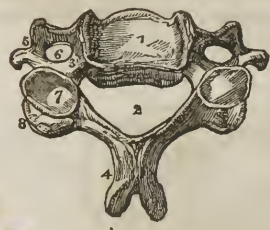


Fig. 23.


Fig. 22 represents the form of one of the vertebræ of the neck. 1, The body. 2, The spinal canal. 3, Half of an opening between the vertebræ. 4, The spinous process cleft at its extremity. 5, The transverse process. 6, A passage for an artery to the brain. 7, The superior oblique process. 8, The inferior oblique process.

Fig. 23. 1, The face of the intervertebral substance that connects the bodies of the vertebræ. 2, The anterior surface of the body of the vertebra. 3, The spinous process. 4, 4, The transverse processes. 5, 5, The oblique processes. 6, 6, A portion of the bony bridge that assists in forming the spinal canal (7.)

Another provision for the protection of the brain, which bears convincing proof of the transcendent wisdom and beneficence of the Creator, is the antero posterior, or forward and backward curve of the spine. Were it a straight column, standing perpendicularly, the slightest jar would cause it to recoil with a sudden jerk. In such a case, the weight bearing equally, the spine would neither yield to the one side or the other. But, shaped as it is, we find it yielding in the direction of the curve.

The PELVIS is composed of four bones; the two *innominata*, the *sacrum*, and the *coccyx*.

The INNOMINATUM, or nameless bone, in the child, consists of three pieces. These, in the adult, become united, and constitute but one bone. In the sides of these bones is a deep depression, like a cup, called the *acetabulum*, in which the head of the thigh bone is placed.

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What do Figs. 22 and 23 represent? What is another provision for the protection of the brain? What would be the effect were the spine a straight column? Of how many bones is the pelvis composed? What is said of the innominatum, in the child? What is said of the innominatum, in the adult? What is the depression in the side of this bone called? What is its use?

The SACRUM, so called, because the ancients offered it in sacrifices, is a wedge-shaped bone, that is placed between the innominata, and to which it is bound by ligaments. Upon its upper surface it connects with the lower vertebra. At its inferior or lower angle, it is united to the coccyx. It is concave upon its anterior, and convex upon its posterior surface.

Fig. 24.


Fig. 24. 1, 1, The innominata. 2, The sacrum. 3, The coccyx. 4, 4, The acetabulum. *a*, *a*, The pubic portion of the innominata; *d*, the arch of the pubes; *e*, the junction of the sacrum and lower lumbar vertebra.

The COCCYX, in infants, consists of several pieces, which, in youth, become united into one bone. This is the terminal extremity of the spinal column. These bones form the walls of a cavity named the *pelvis*.

## BONES OF THE EXTREMITIES.

The bones of the upper and lower limbs are enlarged at each extremity, and have projections that are called processes. To these the tendons of muscles and ligaments are attached, which connect one bone with another. The shaft of these bones is cylindrical and hollow. In structure their exterior surface is hard and compact, while the interior por-

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Describe the sacrum. Describe the coccyx. *Describe the bones of the upper and lower extremities.* What is said of their structure?

tion is of a reticulated character. The enlarged extremities of the round bones are more porous than the main shaft.

Fig. 25.

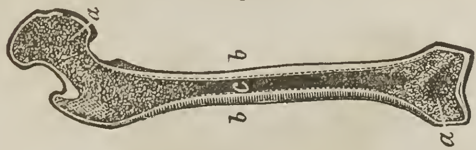


Fig. 25 represents a section of the thigh bone; *a*, *a*, the extremities, having a shell, or thin plate of compact texture covering small cells, diminishing in size, but increasing in number, as they approach the articulation; *c*, the cavity that contains the marrow; *b*, *b*, the walls of the shaft, which are very firm and solid.

## BONES OF THE UPPER EXTREMITIES.

The upper extremities contain the *clavicle*, or collar bone, the *scapula*, or shoulder bone, the *humerus*, or first bone of the arm, the *two bones* of the *fore-arm*, *eight bones* in the *wrist*, *five* in the *hand*, *fourteen* in the *fingers* and *thumb*,—making sixty-four in both arms and hands.

The CLAVICLE is attached, at one extremity, to the *sternum;* at the other, it is united to the *scapula.* It is shaped like the italic *f*. Its use is to keep the arms from sliding towards the breast. This bone can be lengthened by throwing the arms back, consequently enlarging the chest. The French have longer clavicles and broader chests than the Americans, though their stature is smaller. This is the result of their early physical education.

Fig. 26.

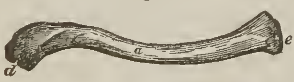


Fig. 26. *a*, The body of the clavicle; *e*, the extremity that articulates with the sternum; *d*, the point where it articulates with the scapula.

The SCAPULA, or shoulder bone, is situated upon the upper and back part of the chest. It is flat, thin, and of a triangular form.

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What does Fig. 25 represent? Name the bones of the upper extremities. How many in number? Where is the clavicle attached? Its form? Its use? How do the collar bones of the French compare in length with the Americans? Where is the shoulder bone situated?

This bone lies upon, and is retained in its position by muscles. By their contractions it may be moved in different directions.

Fig. 27.


Fig. 27. 1, is the inferior angle of the scapula. 2, Body of the bone. 3, Superior angle. 4, Glenoid cavity, upon which the head of the humerus is placed. 5, Acromion process, to which the clavicle is articulated. 6, Spine of the scapula.

The HUMERUS is cylindrical, and forms at the elbow a hinge-like joint, by its junction with the ulna of the fore-arm; at the scapular extremity, it is lodged in the glenoid cavity, where it is surrounded by a membranous bag, called the capsular ligament.

The FORE-ARM contains two bones, named the *radius* and *ulna*.

The ULNA is articulated with the humerus at the elbow, forming a perfect hinge joint.

The RADIUS is articulated with the bones of the carpus, to form the wrist joint. The two bones, at each extremity, articulate with each other, by which union the rotary movement of the hand is permitted.

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How is it retained in its place? How is it moved? Describe Fig. 27. Describe the humerus. How is it attached at the scapular extremity? What are the two bones of the fore-arm called? How is the rotary motion of the hand effected?

The CARPUS, or wrist, is composed of eight bones, ranged in two rows, and so firmly bound together as to permit only a small amount of movement.

Fig. 28.

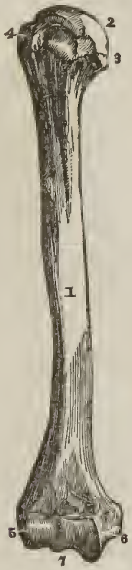


Fig. 29.


Fig. 28. 1, The shaft of the humerus. 2, The large, round head that is placed in the glenoid cavity, forming the shoulder joint. 3 and 4, Tuberosities, to which muscles are attached. 5, Condyle, forming the external elbow. 6, Internal condyle, forming the internal elbow. 7, Articulating surface upon which the ulna rolls.

Fig. 29. 1, The body of the ulna. 2, The shaft of the radius. 3, The upper articulation of the radius and ulna. 4, Articulating cavity, in which the lower extremity of the humerus is placed. 5, Upper extremity of the ulna. called the olecranon process, which forms the point of the elbow. 6, Space between the radius and ulna, filled by the intervening ligament. 7, Styloid process of the ulna. 8, Surface of the radius and the ulna, where they articulate with the bones of the wrist. 9, Styloid process of the radius.

The METACARPUS, or palm of the hand, is composed of five bones, upon four of which, the first range of the finger-bones is placed; and upon the other, the first bone of the thumb is placed. The five metacarpal bones articulate with the second range of carpal bones.

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How many bones in the wrist? Describe Figs. 28 and 29. Where is the first range of finger bones placed? The first bone of the thumb?

The PHALANGES, or fingers, have *three* ranges of bones, while the thumb has but *two*. The bones of the hand and fingers are hollow, and enlarged at each extremity, like the bones of the arm and fore-arm. The articulation of the fingers is similar to that of the elbow and shoulder joints.

Fig. 30.

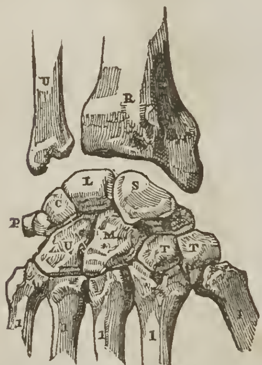

Fig. 31.

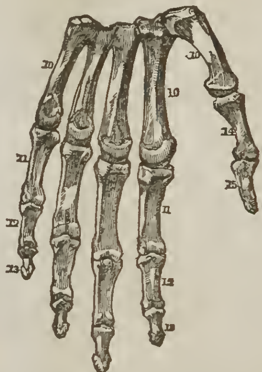

Fig. 30. U, The ulna; R, the radius; S, the scaphoid bone; L, the semilunar bone; C, the cuneiform bone; P, the pisiform bone. These four form the first row. T, T, The trapezium and trapezoid bones; M, the os magnum; U, the unciform bone. These four form the second row. 1, 1, 1, 1, 1, The metacarpal bones of the thumb and fingers.
Fig. 31. 10, 10, 10, The metacarpal bones of the hand. 11, 11, First range of finger bones. 12, 12, Second range of finger bones. 13, 13, Third range of finger bones. 14 and 15, First and second bones of the thumb.

## BONES OF THE LOWER EXTREMITIES.

The lower extremities contain the *femur*, or thigh bone, the *patella*, or knee pan, the *tibia*, the *fibula*, seven bones of the *tarsus*, or instep, five *metatarsal* bones, and fourteen bones of the toes; making in both limbs sixty.

The FEMUR is the longest bone in the system. It supports the weight of the head, trunk, and upper extremities. At its upper extremity, the large, round head is placed in the *acetabulum*. This articulation is a perfect specimen of the ball and socket joint.

This bone articulates with the tibia at its lower extremity.

The PATELLA is a small bone connected with the tibia by

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How many ranges of bones have the fingers? The thumb? What is their structure? Describe Fig. 30 and 31. Name the bones of the lower extremities. Describe the femur, or thigh bone. What kind of joint does it form?

a strong ligament. The tendon of the extensor muscles of the leg is attached to its upper edge. This bone is placed on the anterior part of the lower extremity of the femur, and acts like a pulley in the extension of the limb.

The TIBIA, or shin bone, is the largest bone of the leg. It is of a triangular shape, and enlarged at each extremity.

Fig. 32.

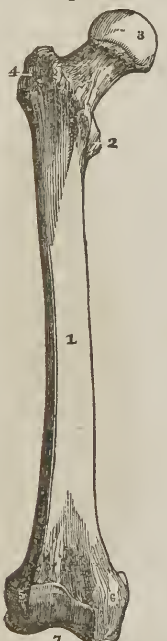


Fig. 33.

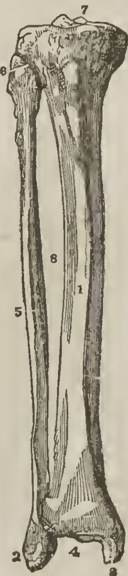


**Fig. 32.** 1, Represents the shaft of the thigh bone. 2, A projection, named the trochantar minor, to which some strong muscles are attached. 4, Trochantar major, to which the large muscles of the hips are united. 3, The round head that enters into the formation of the hip joint. 5, External condyle of the femur. 6, Internal condyle. 7, The surface of the lower extremity of the thigh bone, that articulates with the tibia, and upon which the patella slides.

Fig. 33. 1, Is the tibia. 5, The fibula. 8, The space between the two, filled with the inter-osseous ligaments. 6, The junction of the tibia and fibula at their upper extremity. 2, The external malleolar process, called the external ankle. 3, The internal malleolar process, called the internal ankle. 4, The surface of the lower extremity of the tibia, that unites with the astragulus to form the ankle joint. 7, The upper extremity of the tibia, upon which the condyles of the femur rest.

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Describe the patella. The tibia.

The FIBULA is a smaller bone than the tibia, but of similar shape. It is firmly bound to the tibia, at each extremity. The tibia, the condyles of the femur, and patella, form the knee joint. The tibia and fibula, with one of the tarsal bones, called astragulus, form the ankle joint. This is a perfect specimen of the hinge joint.

The FOOT is composed of three sets of bones. The *tarsal, metatarsal* and *phalangeal.*

The TARSAL, seven in number, are of an irregular form, and firmly bound together, permitting but little movement.

Fig. 34.

Fig. 35.

Fig. 34. A representation of the upper surface of the bones of the foot. 1, The surface of the astragulus, where it unites with the tibia. 2, The body of the astragulus. 3, The calcis, or heel bone. 4, The scaphoid bone. 5, 6, 7, The cuneiform bones. 8, The cuboid. 9, The range of five bones, forming the metatarsus. 10, The first bone of the great toe. 11, The second bone. 12, 13, 14, Three phalanges of bones, forming the small toes.

Fig. 35. A representation of the lower surface of the bones of the foot. 1 and 2, The os calcis, or heel bone. 3, A groove for a tendon. 4, The astragulus bone. 5, The naviculare bone. 6, Its inner tuberosity. 7, The internal cuneiform bone. 8, The middle cuneiform bone. 9, The external cuneiform bone. 10, The cuboid bone. 11, A groove for a tendon. 12, 12, The metatarsal bones. 13, 13, The first phalanges of toes. 14, 14, The second phalanges of toes. 15, 15, The third phalanges of toes. 16, The last phalanx of the great toe.

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The fibula. How is the knee joint formed? How the ankle joint? How many sets of bones in the foot? How many tarsal?

The METATARSAL bones are five in number. They articulate at one extremity with one range of tarsal bones; at the other extremity, with the first range of the toe bones.

The seven *tarsal*, and five *metatarsal* bones are united so as to give the foot an arched form, convex above, and concave below. This structure conduces to the elasticity of the step, and the weight of the body is transmitted to the ground by the spring of the arch, in a manner which prevents injury to the numerous organs.

The PHALANGES, or toe bones, are fourteen in number; each of the small toes has three ranges of bones, while the great toe has but two.

## PERIOSTEUM.

The PERIOSTEUM, from *peri*, around, and *os*, bone, is a firm membrane covering the bones, except where they are tipped with cartilage, and the crowns of the teeth, which are protected by enamel. This membrane has minute nerves, yet, like the bone, when healthy, it possesses but little sensibility. It is the nutrient membrane of the bone, endowing its exterior with vitality; it also gives insertion to the tendons and connecting ligaments of the joints.

When this membrane covers the skull, it is named the *pericranium*, from *peri*, around, and *kranon*, the skull.

## COMPOSITION OF THE BONES.

The bones consist of a mixture of earthy and animal matter; the existence of the first being proved by burning them. By this process they are rendered white, their weight is lessened, and they become brittle, from the absence of animal matter. That which remains is composed of the carbonate and phosphate of lime. The animal part can be made evident by immersing a bone in weak acid. This dissolves the salts of lime, and there remains a cartilaginous body, flexible and elastic, retaining the same form as the bone, and, like cartilage or gristle, it may be knotted.

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How many metatarsal? What form does the union of the bones give the foot? What protection does it give? How many phalanges? How many ranges of bones have the toes? How many the great toe? *Describe the periosteum.* Does this membrane possess sensibility? What is it called on the skull? *Of what are the bones composed?* How demonstrated?

Fig. 36.

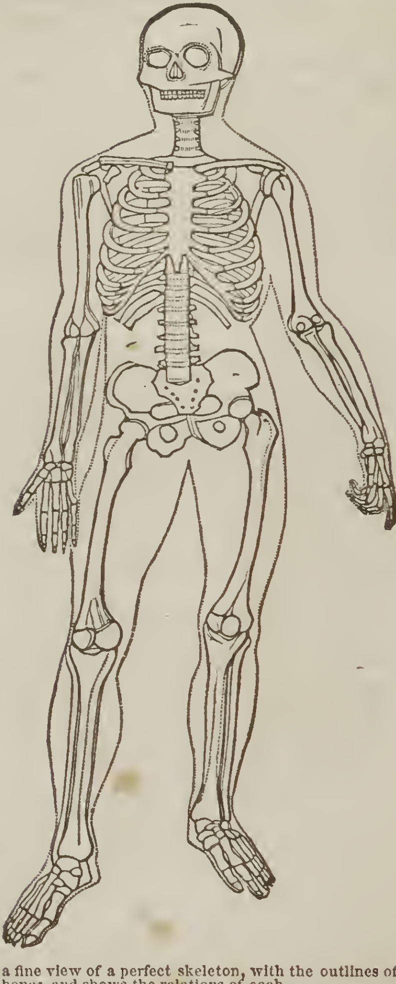

Fig. 36. Gives a fine view of a perfect skeleton, with the outlines of the soft tissues surrounding the bones, and shows the relations of each.

Let the pupil with the plate before him, point out the situation of the *bones* in this engraving; give their names, also a general description of each.

The earthy matter of bones gives them solidity and strength, while the animal part endows them with vitality.

## OSSIFICATION OF THE BONES.

The bones experience many changes before they arrive at maturity. At their early formative stage, they are a cartilage, which is covered by the periosteum. At this period, the vessels of the cartilage convey only the white portion, or lymph of the blood; subsequently they convey red blood. At this time true ossification commences at certain points, which are called *the points of ossification.* Most of the bones are formed of several pieces. This is seen in the long bones which have their extremities separated from the body by a thin partition of cartilage. It is some time before these separate pieces are united to form one bone.

Fig. 37.

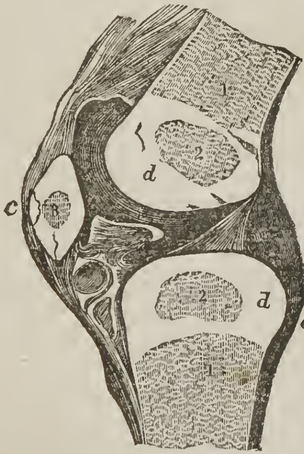


Fig. 37. A section of the knee joint. The lower part of the shaft of the thigh bone, and upper part of the body of the leg bone, are seen ossified at 1, 1. The cartilaginous extremities of the two bones are seen at *d*, *d*. The points of ossification of the extremities, are seen at 2, 2. The patella, or knee-pan, is seen at *c*; the point where ossification commences, is seen at 3.

What are the different uses of the component parts of bone? Do bones change previous to maturity? When they are cartilaginous what fluid passes through them? When does true ossification commence?

When the ossification is completed, the bones still continue to undergo different changes. They increase in bulk, and become less vascular, until middle age. In advanced life, the elevations upon their surface and near the extremities become more prominent, particularly in individuals accustomed to labor. As a person advances in years, the vitality diminishes, and in extreme old age the earthy substance predominates; consequently they are extremely brittle.

The bones are not only supplied with organic nerves, but with *arteries*, *veins*, and *absorbents*.

## PHYSIOLOGY OF THE BONES.

The bones are the frame-work of the system. By their solidity and form, they not only retain every part of the fabric in its proper shape, but afford a firm surface for the attachment of the muscles and ligaments. To give a clear idea of the relative uses of the bones and muscles, we will quote the comparison of another, though, as in other comparisons, there are points of difference. The "bones are to the body what the masts and spars are to the ship, — they give support and the power of resistance. The muscles are to the bones what the ropes are to the masts and spars. The bones are the levers of the system; by the action of the muscles their relative positions are changed. As the masts and spars of a vessel must be sufficiently firm to sustain the action of the ropes, so the bones must possess the same quality to sustain the action of the muscles in the human body." We find them characterized by hardness, inflexibility, insensibility, and strength. By means of the bones the human frame presents to the eye a wonderful piece of mechanism, uniting the most finished symmetry of form with freedom of motion, and also giving security to many important organs.

Some of the bones are designed exclusively for the protection of the organs which they enclose. Of this number are those that form the skull, the sockets of the eye, and the cavity of the nose. Others, in addition to the protection they give to important organs, are useful in movements of certain kinds. Of this class are the bones of the spinal column and ribs.

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What is said of the various changes of the bones after ossification? With what are the bones supplied? *Give the physiology of the bones.* What are the different offices of the bones?

Others are subservient to motion. Of this class are the bones of the upper and lower extremities.

## PRACTICAL SUGGESTIONS.

The health of the bones depends upon a supply of nutrient blood, and proper exercise. As a general thing, we see that among active and industrious men, when digestion is good, the lungs healthy and well-developed, with an abundant supply of pure air, they have also well-developed and well-formed limbs. On the contrary, persons who toil in damp rooms, who sleep in badly ventilated chambers, whose food is poor in quality and deficient in quantity, who pursue a laborious and exhausting occupation for many hours continuously, and in unnatural positions, will have their bones more or less diseased.

The kind and amount of labor should be adapted to the age, health, and development of the bones. The flexible bones of the child, and the brittle bones of the aged man, are not adapted, by their organization, to long-continued and hard labor. Neither are the yielding bones of the child fitted for long-continued sitting or standing in one position. The attempt to induce a child to stand or walk while very young, is unwise, and often productive of injury to the system. The lower limbs being imperfectly developed, and containing but a small amount of earthy salts, bend when the weight of the body is thrown upon them for any length of time.

The bones that compose the spinal column and the ribs are, in the child, very soft and yielding. Such being the case, the clothing should be loosely fitted to the child. A very small amount of pressure upon the gelatinous ribs, will push them in upon the lungs, heart, liver, stomach, and other important internal organs. The hip bones of the child, also, like the other bones, are soft and yielding. If the child be carried much upon one arm around the parlor, deformity may be produced. When it becomes older, the gelatin gives place to the earthy matter, which renders the bones firm to resist the action of the more mature muscles, and the forces operating upon them. As the child advances in years, the bones bend less easily, and are

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*Upon what does the health of the bones depend?* Should labor be adapted to the development of the bones? Why should not the clothing of children be tightly fitted? Should children be carried in one position? How does the quantity of the animal part of the bones compare with the earthy in childhood?

fractured more readily. In middle age, the proportions of gelatin and the carbonate and phosphate of lime are more nearly balanced. The bones, at this period of life, are firm, elastic, and not so readily injured as in younger years, or in more advanced life. In advanced life, as they are found to be friable or brittle, if they are fractured, it will require a greater length of time to unite them than in middle age; for the reason, that the gelatin is diminished, while the salts of lime have been very much increased.

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How does the animal part of the bones compare with the earthy in middle age? In old age? What is the effect of a predominance of earthy matter?

# CHAPTER IV.

## ANATOMY OF THE JOINTS.

THE joints are composed of the *extremities of the bones, cartilages, synovial membrane*, and *ligaments*.

CARTILAGE is a smooth, solid, elastic substance, softer than bone. It forms upon the articular surfaces of the bones a thin incrustation.

The SYNOVIAL MEMBRANE is a thin, membranous layer, which covers the cartilages upon the joints of the bones, whence it is bent back upon the surfaces of the ligaments which surround and enter into the composition of the joints. Besides the synovial membranes, there are numerous smaller sacs of a similar kind, interposed between the surfaces which move upon each other so as to cause friction. These small sacs are often associated with the articulations, and are called the *bursæ mucosæ*. They are shut sacs, analogous in structure to synovial membranes, and secrete a similar synovial fluid. Like the bones, the cartilages, ligaments, and synovial membranes are insensible when in health; yet they are supplied with organic nerves, arteries, veins, and absorbents.

The LIGAMENTS, from the Latin, *ligare*, to tie, are composed of numerous straight fibres, collected together and arranged into short bands of various breadths, or so interwoven as to form a broad layer, which completely surrounds the articular extremities of the bones, and constitutes a capsular ligament. These connecting bands are inelastic, glistening, and possess no sensibility when in health. They are found exterior to the synovial membrane.

As the joints of animals resemble those of man, it would be a good exercise for the student to examine those of the ox or calf. The satin-like bands, called ligaments, will be seen run-

*Name the different parts of a joint.* Describe the cartilage. Describe the synovial membrane. What does it resemble? Describe the bursæ mucosæ. What is said of the sensibility of the cartilages and other parts of the joints? Of what are ligaments composed? What is the character of these connecting bands?

ning from one bone to the other, under which will be seen the membranous bag, called the capsular ligament. This is seen to be very smooth, as it is lined with the soft synovial membrane, beneath which is seen the cartilage, that may be cut with a knife, and under this is seen the rough extremity of the ends of the bone.

The different joints vary in range of movement, and in complexity of structure. Some permit motion in all directions, as the shoulder; some move in two directions, permitting only flexion and extension of the part, as the elbow; while others have no movement, as the bones of the head in the adult. Some joints are formed of two bones, as those of the shoulders, fingers, and toes; some of three bones, as the elbow and ankle; some of more than three, as the wrist, &c.

Fig. 38.

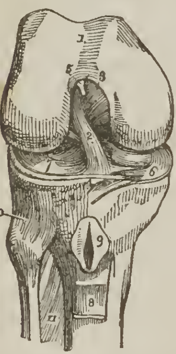

Fig. 39.

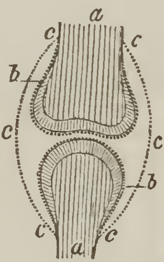

Fig. 40.

Fig. 38. The knee joint laid open. 1, The articular extremity of the thigh bone. 2, 3, The crucial ligaments of the knee. 6, 7, The semi-lunar cartilages of the knee joint. 8, The attachment of the ligament of the patella to the tibia. 9, A bursa mucosa under this ligament. 10, The ligament that binds the tibia and fibula together. 11, The interosseous ligament between the tibia and fibula.

Fig. 39 gives the relative position of the bone, cartilage, and synovial membrane. The bones are indicated by *a*, *a*; *b*, *b*, point out the cartilage covering the ends of these bones, outside of which is a dotted line; this is the synovial membrane, which envelopes the heads of both bones, and is then doubled back from one to the other, as seen at *c*, *c*, *c*, *c*, *c*, *c*.

Fig. 40 finely illustrates the relation of the extremities of the bones, cartilages, synovial membrane, and bursæ mucosæ, in the formation of joints. 1, The femur divided, the articular extremity of which is seen covered by a cartilage. 5, The tibia divided and likewise covered by an articular cartilage. 2, 4, Ligaments attached to the patella (3). ****, The synovial membrane, covering the cartilage that encrusts the extremity of the bones, from which it passes to line the ligaments seen at 12, 2, and the patella at 3. 9, 10, 11, Represent ligaments within the knee joint. 6, A bursa mucosa seen under the tendon that connects the patella and tibia. 7, A mass of fat found around the joints. By comparing figs. 38, 39 and 40, a good idea of the structure and arrangements of the joints can be obtained.

Fig. 41.


Fig. 42.

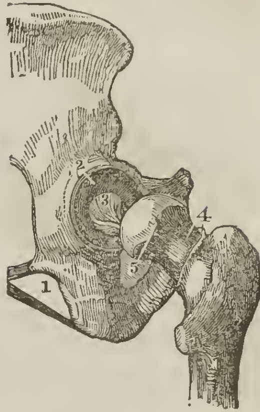


Fig. 41. The ligaments of the pelvis and hip joint. 1, The lower part of the anterior ligament of the vertebræ. 2, A ligament which extends from one of the vertebra to the sacrum. 3, A ligament which extends from the vertebræ to the ilium. 4, Ligaments that connect the ilium and sacrum. 5, The obturator membrane. 6, Poupart's ligament. 7, Gimbernat's ligament. 8, The capsular ligament of the hip joint. 9, The ilio-femoral or accessary ligament.

Fig. 42. 1, The sacro-iliac ligament. 2, The acetabulum. 5. The head of the thigh bone. 4, The neck of the thigh bone. 3, The ligament that binds the head of the thigh bone to the bottom of the acetabulum.

Fig. 43.

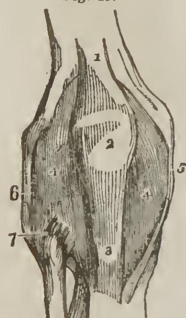


Fig. 44.

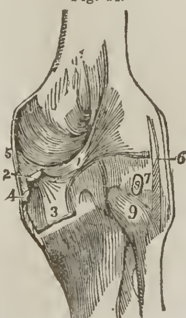


Fig. 43. The anterior ligaments of the knee joint. 1, The tendon of the quadriceps extensor muscle of the leg. 2, The patella. 3, The anterior ligament of the patella, near its insertion. 4, 4, The synovial membrane. 5, The internal lateral ligament. 6. The long external lateral ligament. 7. The anterior and superior ligament that unites the fibula to the tibia.

Fig. 44. The posterior ligaments of the knee joint. 1, The ligament of Winslow. 2, The tendon of semi-membranosus muscle. 3, Its insertion, showing the expansion of its fibres. 5, The internal lateral ligament. 6, 7, The external lateral ligament. 8, The tendon of a muscle cut off. 9, The posterior tibial ligament.

Fig. 45.

Fig. 46.

Fig. 45. An internal view of the ankle joint. 1, The internal malleolus of the tibia. 2, 2, The astragulus bone. 3, The os calcis, or heel bone. 4, Scaphoid bone. 5, Cuneiform bone. 6, A strong ligament that connects the tibia to the calcis. 7, A ligament connecting the tibia to the astragulus. 8, The tendo Achilles, or heel cord.

Fig. 46. An external view of the ankle joint. 1, The tibia. 2, The external malleolus of the fibula. 3, 3, The astragulus. 4, The os calcis. 5, The cuboid bone. 6, The anterior fasciculus of the external lateral ligament attached to the astragulus. 7, Its middle fasciculus attached to the os calcis. 8, Its posterior fasciculus, attached to the astragulus. 9, The anterior ligament of the ankle.

Fig. 47.

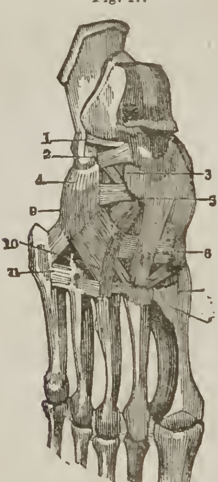

Fig. 48.

Fig. 47. A view of the ligaments upon the upper surface of the foot. 1, 2, Connect the calcis and astragulus bone. 3, Connects the calcis, cuboid, and naviculare bones. 4, Connects the calcis and cuboid bones. 5, Connects the naviculare and cuneiform bones. 6, The dorsal ligament of cuneiform bone. 7, Connects the cuneiform and metatarsal bones. 8, The second metatarsal bone, from which proceed three ligaments to the cuneiform bones. 9, The cuboid bone, from which proceed ligaments to the metatarsal bone. 10, Connects the third cuneiform and third metatarsal bone. 11, A ligament connecting two of the metatarsal bones.

Fig. 48. A view of the ligaments upon the sole of the foot. 1, The calcis bone. 2, The astragulus bone. 3, The naviculare bones. 4, 5, Connect the calcis and cuboid bones. 6, Connects the calcis and naviculare bones. 8, The tendon of a muscle. 9, The ligaments of the tarsal and metatarsal bones. 10, The capsular ligament of the first joint of the great toe. 11, The lateral ligaments of the first joints of the toes.

Fig. 49.

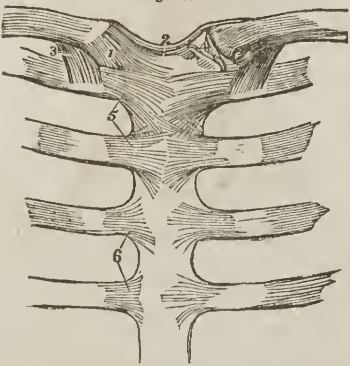

Fig. 50.

Fig. 49. The ligaments that bind the clavicle and ribs to the sternum. 1, The capsular ligament of the articulation of the clavicle and sternum. 2, Connects the two clavicles. 3, Connects the clavicle and first rib. 4, The cartilage between the sternum and clavicle. 5, 6, Connect the ribs and sternum.

Fig. 50. The ligaments of the shoulder joint. 1, Connects the clavicle and acromion process of scapula. 2, Connects the clavicle and coracoid process of scapula. 3, Connects the acromion and coracoid process. 4, The coracoid ligament. 5. The capsular ligament of the shoulder joint. 6, Connects the humerus and coracoid process. 7. The tendon of the long head of the biceps muscle.

Fig. 51.

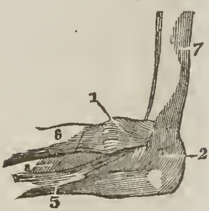

Fig. 52.

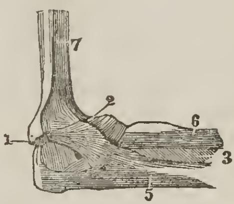

Fig. 51. 7, The humerus. 6, The radius. 5, The ulna. 3, The ligament that connects the radius and ulna. 2, The posterior ligament that connects the humerus and ulna. 1, The external lateral ligament that connects the humerus and radius.

Fig. 52. 7, The humerus. 6, The radius. 5, The ulna. 3, The inter-osseous ligament that connects the radius and ulna. 2, The external lateral ligament. 1, The internal lateral ligament. Fig. 51 is an external view of the joint, while 52 is an internal view.

The elbow is more complicated than the shoulder joint, but is less frequently dislocated; yet, when it is displaced, the injury is more serious and less manageable than in joints of more simple structure. This is true of other complex joints, as the knee and ankle. In no instance, when the ligaments of a joint are in a healthy condition, can there be displacement of the bones without laceration of some of the ligaments, the assertion of empirics to the contrary.

Fig. 53.

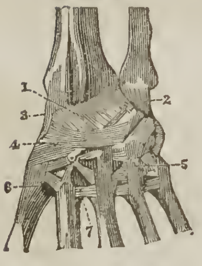

Fig. 54.

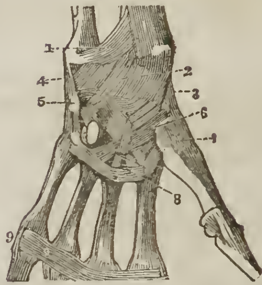

Fig. 53. A posterior view of the ligaments of the lower extremity of the fore-arm, carpus and metacarpus. 1, Connects the ulna and carpal bones. 2, Connects the radius and carpal bones. 3, Connects the ulna and carpal bones. 4, The ligaments that connect the carpal bones. 5, A ligament that connects the carpus and one of the metacarpal bones. 6, A ligament that connects a carpal with a metacarpal bone. 7, One of the dorsal ligaments that unite the metatarsal bones.

Fig. 54. An anterior view of the ligaments that unite the lower extremity of the fore-arm, carpus and metacarpus. 1, connects the radius and ulna. 2, Connects the radius and carpal bones. 3, The external lateral ligament that connects the radius and carpal bone. 4, The internal lateral ligament that connects the ulna and carpal bones. 5, The pisiform bone. 6, The magnum bone. 7, The capsular ligament of metacarpal bone of the thumb. 8, The common transverse palmar ligament that connects the upper extremities of the metacarpal bones. 9, The common transverse ligament that connects the lower extremity of the metatarsal bones.

Fig. 55.

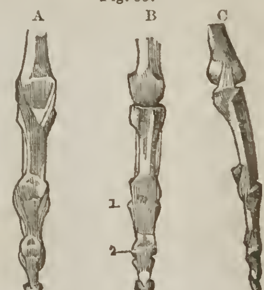


Fig. 55. A, is a front view of the lateral ligaments of the finger joints. B, 1 and 2, is a view of the anterior ligaments of the finger joints. C, is a side view of the lateral ligaments of the finger joints.

## PHYSIOLOGY OF THE JOINTS.

The extremities of the bones which assist in forming the joints, are porous in their texture, and consequently, more elastic, than if they were more compact. These are covered

with a cushion of cartilage. The highly elastic and yielding character of these parts, serves to diminish the jar which the important organs of the system would otherwise receive.

The *synovial membrane* secretes a viscous fluid, which is called *synovia*, from the Greek, *sun*, together, and *ôon*, an egg. This lubricating fluid of the joints enables the surfaces of the bones and tendons to glide smoothly over each other, thus diminishing the friction consequent on their action. In this is manifested the skill and omnipotence of the Great Architect, for no machine of human invention supplies to itself, by its own operations, the necessary lubricating fluid. But, in the animal frame, it is supplied in proper quantities, and applied in the proper place and at the proper time.

It is by the agency of the *ligaments*, that the many small bones of the wrist and foot, as well as the larger bones of the system, are so securely bound together. Some of them are situated within the joints, like a central cord or pivot, (see 3, fig. 42.) Some surround it like a hood, and contain the lubricating synovial fluid, (see 8, 9, fig. 41,) and some in the form of bands at the side, (see fig. 45, 46.)

The ligaments bind the lower jaw to the temporal bones, and the head to the neck. They extend the whole length of the spinal column, in powerful bands, both on the outer surface, within the spinal canal, and from one spinous process to another. They bind the ribs to the vertebræ, to the transverse process behind, and to the sternum in front; and this to the clavicle; and this to the first rib and scapula; and this last to the humerus; and this to the two bones of the fore-arm at the elbow joint; and these to the wrist; and these to each other and to those of the hand; and these last to each other and those of the fingers and thumb. In the same manner, also, they bind the bones of the pelvis together, and the innominatum to the femur, and this to the two bones of the leg and patella, and so on, to the ankle, foot, and toes, as in the upper extremities. Thus the whole system of bones is united and bound together in the most powerful and admirable manner, so as to possess, in a wonderful degree, mobility and firmness.

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*Give the physiology of the joints.* What renders the extremities of the bones more elastic than their centres? What is synovia? Its office? Mention an instance of the superiority of the animal machine over any of human invention. What is the use of ligaments?

### PRACTICAL SUGGESTIONS.

It is seldom that a bone is displaced without injury to the connecting ligaments and membranes. When these connecting bands are lacerated, pain, swelling, and other symptoms indicating inflammation, succeed, which should be removed by proper treatment by a surgical adviser.

In sprains, but few if any of the fibres of the connecting ligaments are lacerated, but they are unduly strained and twisted, which occasions acute pain at the time of the injury. This species of injury to the system is followed by inflammation and weakness of the joints. The treatment of these injuries is similar to that of a dislocated bone after its reduction. The most important thing is rest.

In persons of scrofulous constitutions, and those in whom the system is enfeebled by disease, white-swellings, and other chronic diseases of the joints frequently succeed sprains. Such persons cannot be too assiduous in adopting a proper and early treatment of injured joints.

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When we sprain a joint what are injured? What treatment should be adopted?

# CHAPTER V.

## ANATOMY OF THE MUSCULAR SYSTEM.

Muscles are the moving organs of the animal frame. They constitute, by their size and number, the great bulk of the body, upon which they bestow form and symmetry. In the limbs, they are situated around the bones, which they invest and defend, while they form, to some of the joints, their principal protection. In the trunk, they are spread out to enclose cavities, and constitute a defensive wall, capable of yielding to internal pressure, and returning again to its original form.

Their color is a deep red, which is characteristic of *flesh*, and their form is variously modified, to execute the varied range of movements which they are required to effect.

Muscle is composed of a number of parallel fibres, placed side by side, and supported and held together by a delicate web of cellular tissue. Towards the extremity of the organ the muscular fibre ceases, and the cellular structure becomes aggregated and so modified as to constitute those cords called *tendons*, by which the muscle is tied to the surface of the bone. The union is so firm, that, under extreme violence, the bone will sooner break than permit the tendon to separate from its attachment.

In the broad muscles, the tendon is spread so as to form an expansion called *aponeurosis*. Muscles present various modifications in the arrangement of their fibres in relation to their tendinous structure. Sometimes they are completely longitudinal, and terminate, at each extremity, in a tendon, the entire muscle being spindle shaped. In other situations they are disposed like the rays of a fan, converging to a tendinous

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*What are the muscles?* What give symmetry of form to the human frame? How are they situated in the limbs? In the trunk? What is their color? Of what is muscle composed? Describe tendons. What is said of the union of the tendons with the bone? Describe some of the different forms of muscles.

point, and constituting a *radiate* muscle. Again they are *penniform*, converging, like the plumes of a pen, to one side of a tendon, which runs the whole length of the muscle, or they are *bipenniform*, converging to both sides of the tendon.

Fig. 56.


Fig. 56. 1, Represents the direction and arrangement of the fibres in a fusiform or spindle shaped muscle; 2, in a radiated muscle; 3, in a penniform muscle; 4, in a bipenniform muscle.

In the description of a muscle, we express its attachment by the terms "origin" and "insertion." The term origin is generally applied to the more fixed or central attachment, or to the point toward which motion is directed; while insertion is assigned to the more movable point, or to that most distant from the centre. The middle, fleshy portion, is called the "belly."

Fig. 57.

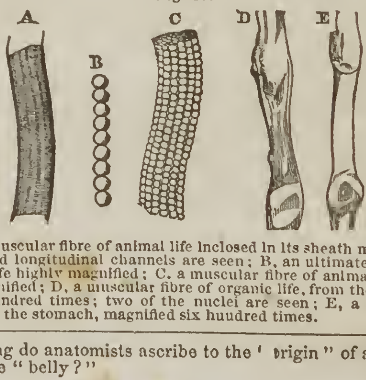


Fig. 57. A, a muscular fibre of animal life inclosed in its sheath magnified, in which the transverse and longitudinal channels are seen; B, an ultimate fibril of muscular fibre of animal life highly magnified; C. a muscular fibre of animal life, similar, but more highly magnified; D, a muscular fibre of organic life, from the urinary bladder, magnified six hundred times; two of the nuclei are seen; E, a muscular fibre of organic life, from the stomach, magnified six huudred times.

What meaning do anatomists ascribe to the "origin" of a muscle? "Insertion?" The "belly?"

Two kinds of muscular fibres exist in the animal economy, viz.: that of voluntary, or animal life, and that of involuntary, or organic life.

Fig. 58.

Fig. 58. Represents the superficial layer of muscles on the face and neck. 1, 1, The occipito-frontalis muscle. 2, The orbicularis palpebrarum. 3, The nasal slip of the occipito-frontalis. 4, The anterior auriculæ. 5, The compressor naris. 6, The levator labii superioris alæque nasi. 7, The levator anguli oris. 8, The zygomaticus minor. 9. The zygomaticus major. 10, The masseter. 11, The depressor labii superioris. 12, The buccinator. 13, The orbicularis oris. 14, The denuded lower jaw. 15, The depressor anguli oris. 16, The depressor labii inferioris. 17, A portion of the platysma-myodes. 18, The sterno-hyoideus. 19, The platysma-myodes. 20, The superior belly of the omo-hyoideus. 21, The sterno-cleido mastoideus. 22, The scalenus medius. 23, The inferior belly of the omo-hyoideus. 24, The trapezius.

The muscle 2, closes the eye. The muscle 13, closes the mouth. The muscle 11, elevates the upper lip. The muscle 16, depresses the lower lip. The muscles 7, 8, 9, elevate the angle of the mouth. The muscle 15, depresses the angle of the mouth. The muscles 18, 19, 20, 23, depresses the lower jaw and larynx, or elevates the sternum. The muscle 21, when both sides contract, draws the head forward, or elevates the sternum; when only one contracts, the face is turned one side towards the opposite shoulder.

Note. — Let the pupil, in describing the engravings of the muscular system, call into action the different muscles; as, in elevating the angle of the mouth by contracting muscles 8, 9 and 10. The effect of the contraction of other muscles on the system, and their attachments, can be noted in the same manner.

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How many kinds of muscular fibre in the animal economy? Explain the office of the different muscles represented in Fig. 58, from the engraving.

The fibre of animal life is marked by transverse channels; the fibre of organic life has no transverse channels and is much smaller than the fibre of animal life. The most remarkable characteristic of organic life is the existence, from point to point, of swellings somewhat larger than the diameter of the fibre.

Fig. 59.


Fig. 59. Represents the deep layer of muscles of the face and neck. 1, 1, The temporalis muscle. 2, The eye-ball. 3, The corrugator supercilii. 4, Insertion of the orbicularis palpebrarum. 5, The anterior auriculæ. 6 and 8, The levator labii superioris alæque nasi. 7, The compressor naris. 9, The levator anguli oris. 10, 11, The depressor labii superioris alæque nasi. 12, The buccinator. 13, The masseter. 14, 15, The orbicularis oris 16, The depressor anguli oris. 17, The levator labii inferioris. 18, The depressor labii inferioris. 19, The adipose tissue on the chin. 20, The scalenus medius. 21, The sterno-hyoideus. 22, The omo-hyoideus. 23, The sterno-cleido-mastoideus. 24, The trapezius. 25, Fascia attached to the clavicle.

The muscles 1 and 13, elevate the lower jaw, and bring the teeth together. The muscle 3, closes the eye. The muscles 14, 15, close the mouth. The muscles 6, 8, 9, elevate the angle of the mouth. The muscle 16, depresses the angle of the mouth. The muscles 10, 11, elevate the upper lip. The muscle 18 depresses the lower lip. The muscles 20, 21, 22, depress the larynx, or elevate the sternum. The muscle 23 draws the head forward, or elevates the sternum, when both act; but when only one acts, the face is turned toward one shoulder.

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How is the fibre of animal life marked? Of organic life? What is the most remarkable characteristic of organic life? Describe Fig. 59.

In structure, muscle is composed of bundles of fibres, of variable size, called *fasciculi*. These are enclosed in a cellular, membranous investment, or sheath. Each *fasciculus* is composed of a number of smaller bundles of single fibres. These have been distinguished by the name of *ultimate fibres.* The ultimate fibres consist of a number of *ultimate fibrils*, enclosed in a delicate sheath.

Every muscle and each muscular fibre is supplied with arteries, veins, absorbents, and both sentient and motive nervous filaments.

Fig. 60.

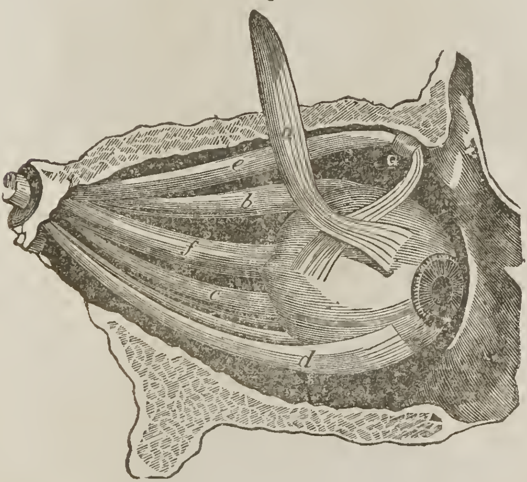


Fig. 60. Represents the muscles of the eye. The bone above and below the eye is seen in its relative position. *a*, The external rectus muscle, the posterior attachment separated and raised. *b*, The superior rectus. *c*, The internal rectus. *d*, The inferior rectus. *e*, The superior oblique. G, The trochlea, or pully through which its tendon passes. The use of this tendon is to change the direction of the action of this muscle. *f*, The optic nerve.

The muscle *a*, turns the eye out. The muscle *b*, rolls it upward. The muscle *c*, turns it towards the nose. The muscle *d*, turns it downward. The muscle *e*, rolls it downward and inward.

The number of muscles in the human body is more than four hundred; in general, they form about the skeleton two

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What is meant by the term "fasciculi?" With what is every muscular fibre supplied? Describe Fig. 60. How many muscles in the human body?

layers, and are distinguished into superficial and deep-seated. The names of the different muscles, or a description of them separately, are not given, on account of their number; and acquiring their names and their origin and attachment, would not only be tedious, but of no *practical* utility.

Fig. 61.

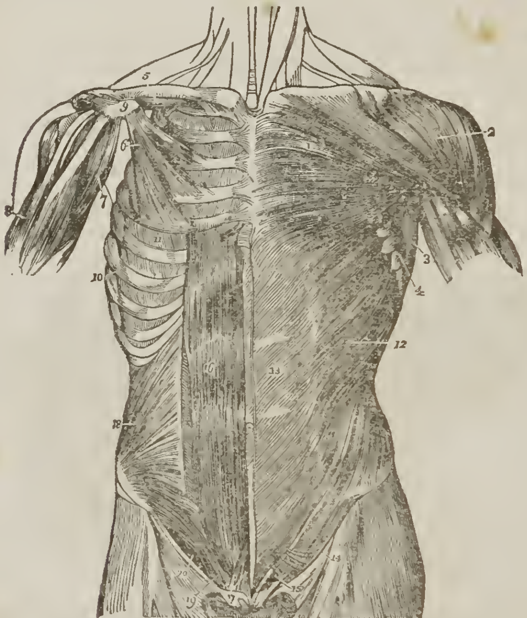

Fig. 61. Represents the muscles of the anterior aspect of the trunk. On the left side, the superficial layer is seen; on the right, the deeper layer. 1, The pectoralis major muscle. 2, The deltoid. 3, The border of the latissimus dorsi. 4, The serrations of the serratus magnus. 5, The subclavius. 6, The pectoralis minor. 7, The coraco-brachialis. 8, The upper part of the biceps, showing its two heads. 9, The coracoid process of scapula. 10, The serratus magnus of the right side. 11, The external intercostal muscle. 12, The external oblique. 13, Its aponeurosis. 14, Poupart's ligament. 15, The external abdominal ring. 16, The rectus muscle of the right side. 17, The pyramidalis. 18, The internal oblique. 19, The conjoined tendon of the internal oblique and transversalis muscle. 20, The arch formed by the lower border of the external oblique muscle and Poupart's ligament. It is beneath this arch that the intestines pass in femoral hernia or rupture.

The muscle 1, draws the arm by the side, and across the chest, and likewise the scapula forward. The muscle 2, elevates the arm. The muscle 6, elevates the ribs when the scapula is fixed, or draws the scapula forward and downward when the ribs are fixed. The muscles 12, 16, 17, and 18, bend the body forward or elevate the hips when the muscles of both sides act. They likewise depress the ribs in expiration. When the muscles on one side only act, the body is twisted to the same side.

How distinguished? Describe Fig. 61.

Muscles are divided into two great classes; voluntary and involuntary. They may be arranged in conformity with the general division of the body, into — 1. Those of the head and neck. 2. Those of the trunk. 3. Those of the upper extremity. 4. Those of the lower extremity.

The muscles of the HEAD and NECK are represented in figs. 58, 59 and 60. The interstices between the different muscles are filled with adipose matter or fat. To the presence of this tissue, youth is indebted for roundness and beauty of form.

The muscles of the TRUNK may be thus divided — 1st. Those of the thorax and abdomen. 2d. The muscles of the back.

Fig. 62.

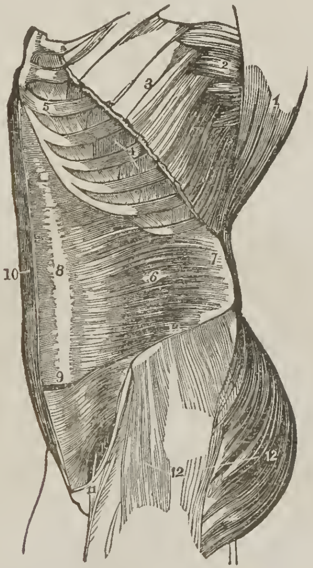

Fig. 62. Represents a lateral view of the trunk of the body. 1, The costal origin of the lattissimus dorsi muscle. 2, The serratus magnus. 3, The upper part of the external oblique. 4, Two of the external intercostals. 5, Two of the internal intercostals. 6, The transversalis. 7, Its posterior aponeurosis. 8, Its anterior aponeurosis. 10, The right rectus muscle. 11, The arched opening left by Poupart's ligament, through which femoral hernia passes. 12, 12, The gluteus maximus and tensor femoris muscles. 13, The crest of the ilium or haunch bone.

The recti muscles bend the thorax upon the abdomen, and through the medium of the transverse lines, are enabled to

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Into how many classes are muscles divided?

act when their sheath is curved inwards by the action of the transversales. The abdominal muscles are expiratory, and the chief agents for expelling the residuum from the rectum, the bile from the gall bladder, the contents of the stomach and bowels in vomiting, and the mucus and irritating substances from the bronchial tubes, trachea, and nasal passages by coughing and sneezing. To produce these effects they all act together. Their violent and continued action sometimes produces hernia, and when spasmodic may occasion ruptures of the different organs.

The contraction and relaxation of the abdominal muscles and diaphragm, stimulate the stomach, liver, and intestines to a healthy action, and are subservient to the digestive powers. If the contractility of their muscular fibres is destroyed, or impaired, the tone of the digestive apparatus will be diminished by the deficient action of the abdominal muscles, as is the case in indigestion and costiveness. This is frequently attended by a displacement of those organs, as they gravitate

Fig. 63.

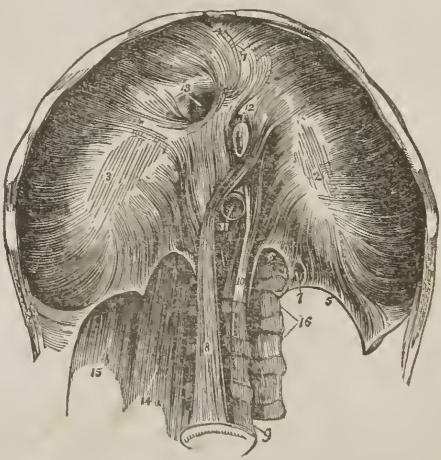


Fig. 63. Represents the under or abdominal side of the diaphragm. 1, 2, 3, and 4, The larger muscle, which is attached to the margin of the ribs. 5,6, The ligament arcuatum. 7, A small opening for one of the splanchnic nerves. 8, and 10, the two fleshy pillars of the diaphragm, which are attached to the third and fourth lumbar vertebræ. 9, The vertebra. 11, The opening for the passage of the aorta. 12, The opening for the œsophagus. 13, The opening for the vena cava ascendens. 14, The psoas magnus muscle. 15, The quadratus lumborum.

to the lower portion of the abdominal cavity, when the abdominal muscles lose their tone and become relaxed.

The DIAPHRAGM is the muscular division between the thorax and abdomen. It is composed of two portions, a greater and lesser muscle. The *greater muscle* arises from the cartilage on the inner surface of the six inferior ribs. From these points, which form the internal circumference of the trunk, the fibres converge and are inserted into the central tendon. The *lesser muscle* takes its origin from the lumbar vertebræ by two tendons.

The muscles of the back are numerous, and may be arranged in six layers.

Fig. 64.

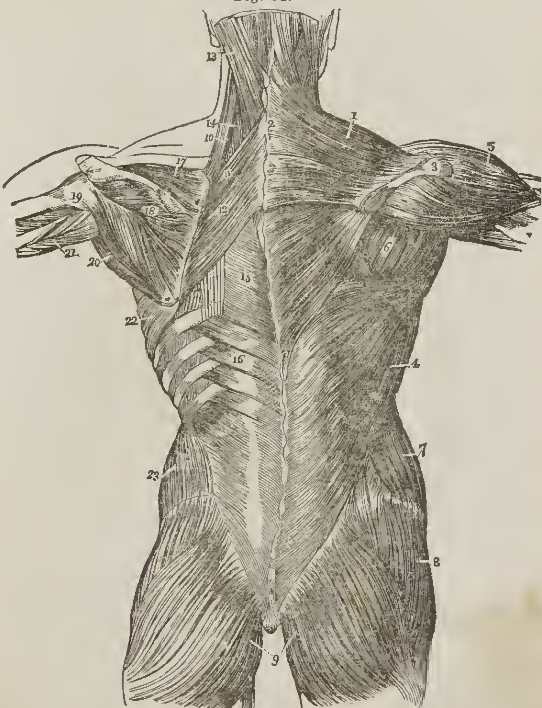


Fig. 64. Represents the first, second, and part of the third layer of muscles of the back. The first layer is shown on the right, and the second on the left side

1, The trapezius muscle. 2, The spinous processes of the vertebræ. 3, The acromion process and spine of the scapula. 4, The latissimus dorsi muscle. 5, The deltoid. 6, The muscles of the back of the scapula, named infra spinatus, teres minor, and teres major. 7, The external oblique. 8, The gluteus medius. 9, The gluteus maximus. 10, The levator scapulæ. 11 and 12, The rhomboideus major and minor. 13, The splenius capitis. 14, The splenius colli. 15, The vertebral aponeurosis. 16, The serratus posticus inferior muscle. 17, The supra-spinatus. 18, The infra-spinatus 19, The teres minor. 20, The teres major. 21, The long head of the triceps, passing between the teres minor and major to the upper arm. 22, The serratus magnus, proceeding from its origin to the base of the scapula. 23, The internal oblique muscle.

The muscles 1, 11 and 12, draw the scapula back towards the spine. The muscles 10, 11 and 12, draw the scapula upward toward the head, and slightly backward. The muscle 4, draws the arm by the side, and backward. The muscles 5 and 17, elevate the arm. The muscles 8 and 9, extend the thigh on the body. The muscles 1, 13 and 14, draw the head back and elevate the chin. The muscles 18, 19 and 20, draw the arm to the side and roll the hand out. The muscle 16 depresses the ribs in expiration. The muscle 22, elevates the ribs in inspiration.

Fig. 65.

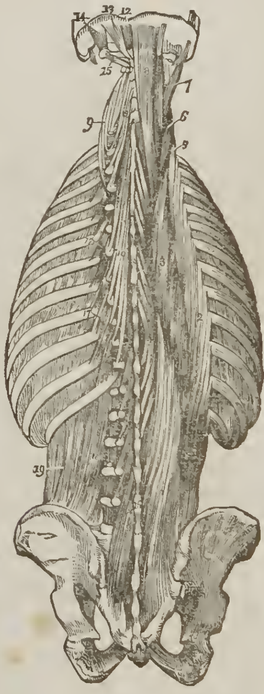

Fig. 65. Represents the fourth, fifth, and part of the sixth layer of the muscles of the back 1, The erector spinæ muscle. 2, The sacro-lumbalis. 3, The longissimus dorsi. 4, The spinalis dorsi. 5, The cervicalis descendens. 6, The transver-

salis colli. 7, The trachelo-mastoideus. 8, The complexus. 9, The transversalis colli. 10, The semi-spinalis dorsi. 11, The semi-spinalis colli. 12, The rectus capitis posticus minor. 13, The rectus capitis posticus major. 14, The obliquus capitis superior. 15, The obliquus capitis inferior. 16, The multifidus spinæ. 17, 17, The levatores costarum. 18, The inter-transversalis. 19, The quadratus lumborum.

The muscles 1, 2, 3, 4, 10, 16, 18 and 19, by their contraction, keep the spinal column erect, when the muscles of both sides act; but when the muscles on one side only are called into action, the spine and body are curved laterally. The muscles 5, 6, 7, 8, 9, 11, 12 and 13, draw the head back and elevate the chin, when the muscles on both sides act; but when those on one side only contract, the head is drawn backward and to one side. The muscles 14 and 15, by their contraction, produce a rotary movement of the head. The muscles 17, 17, elevate the ribs in inspiration.

## MUSCLES OF THE EXTREMITIES.

The muscles of the UPPER EXTREMITIES are — 1. The muscles of the arm. 2. The muscles of the fore-arm. 3. The muscles of the hand.

Fig. 66.

Fig. 67.

Fig. 66. Represents the muscles on the anterior aspect of the arm. 1, The coracoid process of scapula. 2, 3, Ligaments passing from coracoid process to the clavicle and acromion process. 4, The subscapularis muscle. 5, The teres major. 6, The coraco-brachialis. 7, The biceps. 8, The upper end of the radius. 9, The brachialus anticus muscle. 10, The internal head of triceps.

The muscles 7 and 9, bend the arm at the elbow.

Fig 67. Represents a posterior view of the upper arm, showing the triceps muscle. 1, Its external head. 2, Its long, or scapular head. 3, Its internal, or short head. 4, The olecranon process of the ulna. 6, The capsular ligament of the shoulder joint.

The triceps muscle extends the arm at the elbow.

Fig. 68.

Fig. 69.

Fig. 68. Represents the superficial layer of muscles on the anterior aspect of the fore-arm. 1, The lower part of the biceps muscle, with its tendon. 2, A part of the brachialis anticus seen beneath the biceps. 3, A part of the triceps. 4, The pronator radii teres. 5, The flexor carpi radialis. 6, The palmaris longus. 7, One of the fasciculi of the flexor sublimis digitorum; the rest of the muscle is seen beneath the tendons of the palmaris longus and flexor carpi radialis. 8, The flexor carpi ulnaris. 9, The palmar fascia. 10, The palmaris brevis muscle. 11, The abductor pollicis 12, One portion of the flexor brevis pollicis. 13, The supinator longus. 14, The extensor ossis metacarpi and extensor primi internodii pollicis, curving around the lower border of the fore-arm. 15, The anterior portion of the annular ligament, which binds the tendons in their places.

The muscles 5, 6 and 8 bend the wrist on the bones of the fore-arm. The muscle 7 bends the second range of finger bones on the first. The muscle 11 draws the thumb from the fingers. The muscle 12 flexes the thumb. The muscle 13 turns the palm of the hand upward. The muscles 8, 13 and 14 move the hand laterally.

Fig. 69. Represents the deep layer of muscles on the anterior aspect of the fore-arm. 1. The internal lateral ligament of the elbow joint. 2, The anterior ligament. 3, The orbicular ligament of the head of the radius. 4, The flexor profundus digitorum muscle. 5, The flexor longus pollicis. 6, The pronator quadratus. 7, The abductor pollicis. 8, 9, The palmar interosseous muscles of the middle and little fingers.

The muscle 4 bends the last range of finger bones upon the second. The muscle 5 bends the last joint of the thumb. The muscle 6 turns the back of the hand up. The muscle 7 draws the thumb towards the hand. The muscles 8 and 9 draw the bones of the hand and fingers towards each other.

Fig. 70.

Fig. 71.

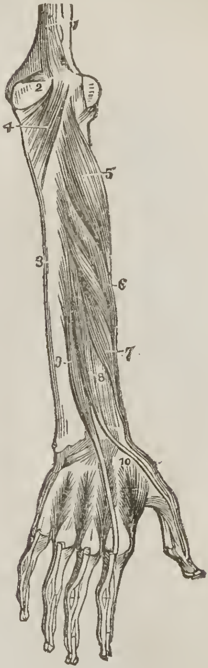

**Fig. 70.** The superficial layer of muscles on the posterior aspect of the fore-arm. 1, The lower part of the biceps muscle. 2, Part of the brachialis anticus. 3, The lower part of the triceps inserted into the olecranon. 4, The supinator longus. 5, The extensor carpi radialis longior. 6, The extensor carpi radialis brevior. 7, The tendons of insertion of these two muscles 8, The extensor communis digitorum. 9, The extensor minimi digiti. 10, The extensor carpi ulnaris. 11, The anconeus. 12. Part of the flexor carpi ulnaris 13, The extensor ossis metacarpi and extensor primi internodii lying together. 14, The extensor secundi internodii; its tendon is seen crossing the two tendons of the extensor carpi radialis longior and brevior. 15, The posterior annular ligament. The tendons of the common extensor are seen on the back of the hand, and their mode of distribution on the back of the fingers.

The muscles 5, 6 and 10 extend the wrist on the fore-arm. The muscle 8 extends the fingers. The muscle 9 extends the little finger. The muscle 13 extends the metacarpal bone of the thumb, and its first phalanx. The muscle 14 extends the last bone of the thumb. The muscles 10, 13 and 14 move the hand laterally.

**Fig. 71.** The deep layer of muscles on the posterior aspect of the fore-arm. 1, The lower part of the humerus. 2, The olecranon. 3. The ulna. 4, The anconeus muscle. 5, The supinator brevis. 6, The extensor ossis metacarpi pollicis. 7, The extensor primi internodii pollicis. 8. The extensor secundi internodii pollicis. 9, The extensor

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Describe Figs. 70, 71, 72, 73, 74, 75.

indicis. 10, The first dorsal interosseous muscle. The other three dorsal interosseous muscles are seen between the metacarpal bones of their respective fingers.

The muscle 5 turns the palm of the hand up. The muscle 6 extends the metacarpal bone of the thumb. The muscles 7 and 8 extend the first and second bones of the thumb. The muscle 9 extends the fore-finger.

Fig. 72.

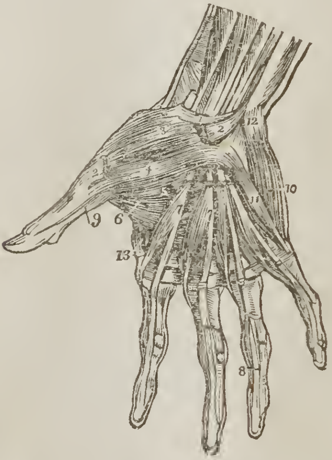


**Fig. 72.** Represents the muscles of the hand. 2, 2, The origin and insertion of the abductor pollicis muscle. 3, The opponens pollicis. 4, 5, The bellies of the flexor brevis pollicis. 6, The adductor pollicis. 7, 7, The lumbricales muscles, arising from the tendons of the deep flexor upon which the numbers are placed. The tendons of the flexor sublimis have been removed from the palm of the hand. 8, One of the tendons of the deep flexor, passing between the two terminal slips of the flexor sublimis to reach the last phalanx. All the tendons of the deep flexor pass through a similar slip in the tendons of the flexor sublimis. 9, The tendon of the flexor longus pollicis, passing between the two portions of the flexor brevis to the first phalanx. 10, The abductor minimi digiti. 11, The flexor brevis minimi digiti. 12, The prominence of the pisiform bone. 13, The first dorsal interosseous muscle.

The muscle 3 bends the metacarpal bone and first phalanx of the thumb. The muscles 4, 5 and 6 draw the thumb towards the hand. The muscle 10 separates the little finger from the ring finger. The muscle 11 bends the little finger. The muscles 7, 10, and 13 move the fingers laterally.

In the hand are found many short muscles, (as represented in fig. 72,) which aid the large muscles of the fore-arm in bending and extending the fingers. In the varied and rapid movements of the fingers in writing, playing upon musical instruments, and other mechanical operations, these muscles are the principal motive agents. Not only their size, but the rapidity and variety of their movements, may be much increased by a course of systematic training. To have these muscles act with celerity and ease, in executing penmanship, or playing upon musical instruments, they should be trained or educated in early youth. It is well known, that those individuals who are taught to play upon the piano or organ, in childhood, sweep the keys with more dexterity and grace than those who learn to play later in life. Hence, an individual who selects and acquires a trade in early life, becomes a more skilful and expert workman than one who commences his mechanical art at a later period.

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What is said of the short muscles of the hand?

The muscles of the LOWER EXTREMITIES may be divided into 1. Those of the thigh. 2. Those of the leg. 3. Those of the foot.

Fig. 73.

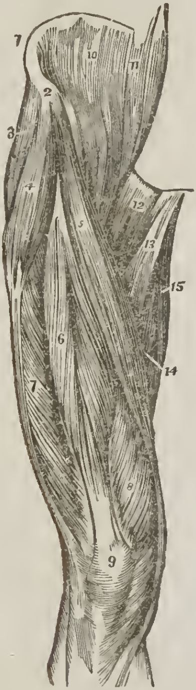


Fig. 74.

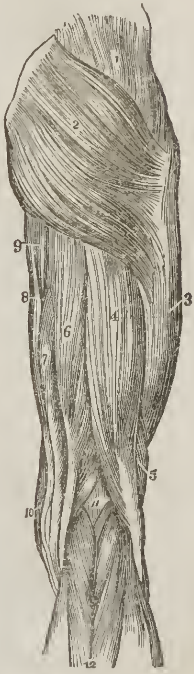


Fig. 73. The muscles of the anterior femoral region. 1, The crest of the ilium. 2, Its anterior superior spinous process. 3, The gluteus medius muscle. 4, The tensor femoris; its insertion into the fascia lata is shown inferiorly. 5, The sartorius. 6, The rectus. 7, The vastus externus. 8, The vastus internus. 9, The patella. 10, The iliacus internus. 11, The psoas magnus. 12, The pectineus. 13, The adductor longus. 14, Part of the adductor magnus. 15, The gracilis.

The muscle 5 draws one limb over the other, as a tailor does when sitting upon his bench. The muscles 6, 7 and 8 extend the leg at the knee. The muscles 10 and 11 bend the thigh at the hip. The muscles 12, 13 and 14 draw one limb towards the other.

Fig. 74. The posterior femoral and gluteal region. 1, The gluteus medius muscle, 2, The gluteus maximus. 3, The vastus externus. 4, The long head of the biceps. 5. Its short head. 6, The semi-tendinosus. 7, The semi-membranosus. 8, The gracilis. 9, A part of the inner border of the adductor magnus. 10, The edge of the sartorius. 11, The popliteal space, or ham. 12, The gastrocnemius muscle; its two heads. The tendon of the biceps forms the outer hamstring; and the tendons of the gracilis, semi-tendinosus and semi-membranosus, form the inner hamstring.

The muscles 1 and 2 extend the thigh on the body. The muscles 4, 5, 6, 7 and 8 bend the leg at the knee.

Fig. 75.


Fig. 76.


**Fig. 75.** Represents the muscles of the anterior aspect of the leg and foot. 1, The tendon of the extensor muscles inserted into the patella. 2, The tibia. 3, The tibialis anticus muscle. 4, The extensor communis digitorum. 5, The extensor proprius pollicis. 6, The peroneus tertius. 7, The peroneus longus. 8, The peroneus brevis. 9, 9, Borders of the soleus muscle. 10, A part of the inner belly of the gastrocnemius. 11, The extensor brevis digitorum; the tendon in front of this number is that of the peroneus tertius; and that behind it, the tendon of the peroneus brevis. 12, The annular ligament of the ankle, that retains the long tendons in their places.

The muscle 3 bends the foot on the leg at the ankle. The muscles 4 and 11 extend the four small toes. The muscle 5 extends the great toe. The muscles 6 and 7 flex the foot and turn it out. The muscles 9 and 10 extend the foot at the ankle.

Fig 76. Represents the superficial muscles of the posterior aspect of the leg. 1, The biceps muscle. 2, The tendons forming the inner hamstring. 3, The popliteal space. 4, The gastrocnemius muscle. 5, 5, The soleus. 6, The tendo-Achilles. 7, The posterior tuberosity of the os calcis. 8, The tendons of the peroneus longus and brevis muscles passing behind the outer ankle.

The muscles 4, 5, 5, extend the foot on the leg at the ankle.

The muscles represented in Figs. 75 and 76, are composed of coarse fibres; they terminate in strong tendons, which make their attachments to the bones of the leg, foot and toes. These muscles, from their size, structure, and attachments, are better adapted for strength and long-continued action, than for rapid movements.

Fig. 77.

Fig. 78.

Fig. 77. Represents the first layer of muscles of the sole of the foot; this layer is exposed by the removal of the plantar fascia. 1, The os calcis. 2, The posterior part of the plantar fascia divided transversely. 3, The adductor pollicis muscle. 4, The adductor minimi digiti. 5, The flexor brevis digitorum. 6, The tendon of the flexor longus pollicis muscle. 7, 7, The lumbricales, on the second and third toes, the tendons of the flexor longus digitorum, are seen passing through the bifurcation of the tendons of the flexor brevis digitorum on these toes.

The muscle 3 separates the great toe from the others. The muscle 4 separates the small toe from the other toes. The muscle 5 bends the four small toes. The muscle 6 flexes the great toe. The muscles 7, 7, move the toes laterally.

Fig. 78. Represents the third and part of the second layer of muscles of the sole of the foot. 1, The divided edge of the plantar fascia. 2, The musculus accessorius. 3, The tendon of the flexor longus digitorum muscle, previous to its division. 4, The tendon of the flexor longus pollicis. 5, The flexor brevis pollicis. 6, The adductor pollicis. 7, The flexor brevis minimi digiti. 8, The transversus pedis. 9, Interossei muscles, plantar and dorsal. 10, A convex ridge formed by the tendon of the peroneus longus muscle in its oblique course across the foot.

The muscle 2 assists in bending the toes. The muscle 5 bends the great toe. The muscle 6 draws the great toe towards the others. The muscle 7 bends the small toe. The muscle 8 draws the metatarsal bones toward each other. The muscle 9 moves the toes laterally.

There are upon the foot, as well as on the hand, many short muscles, as represented in Figs. 75, 77 and 78. These muscles (represented in Figs. 77 and 78) aid the larger muscles upon the leg, in bending and extending the bones of the foot; but they are principally subservient to the lateral, oblique, and more delicate and rapid movements performed by these parts. Ordinarily, the range of movement in the lower extremities is more limited than the upper; yet, instances have been known, in which the upper extremities were wanting, of persons acquiring skill in penmanship, and various mechanical arts.

In the year 1825, there was a young artist in Paris, who had neither hands nor arms, and only four toes on each foot; and yet, by untiring perseverance and practice, he was able to sketch and paint beautifully with his feet.

Fig. 79.

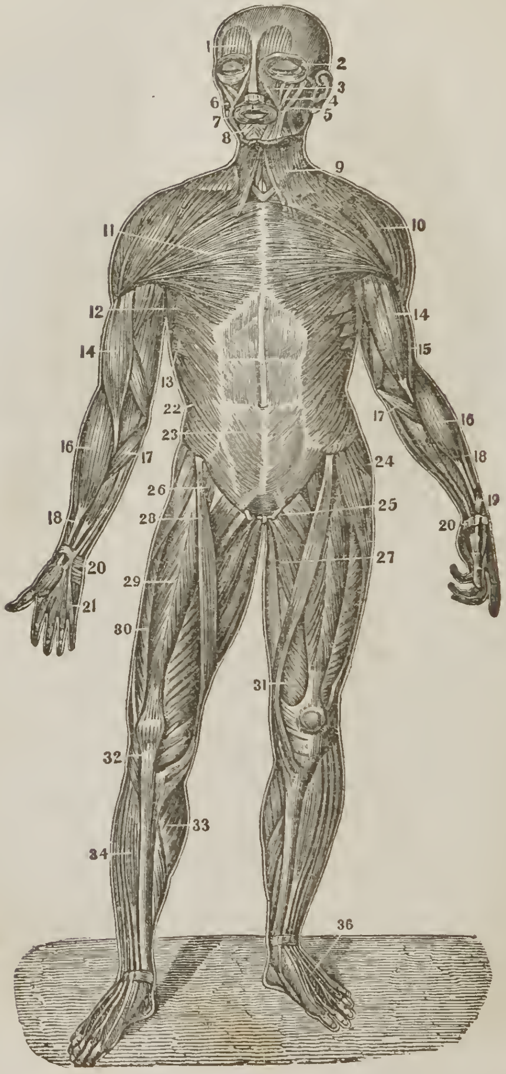
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Fig. 80.

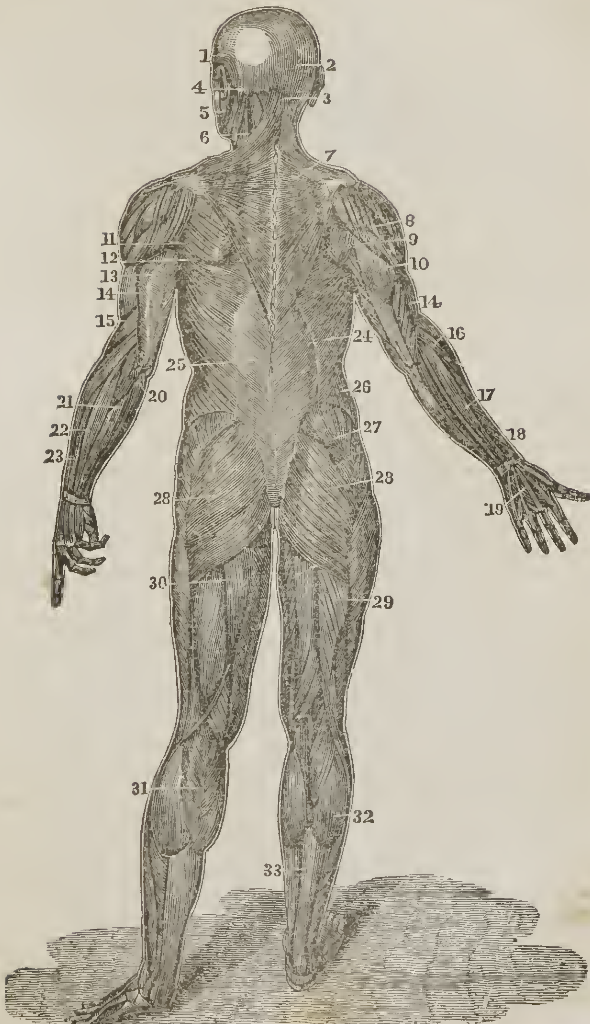
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Fig. 79. An anterior view of the muscles of the body. 1, The frontal bellies of the occipito-frontalis. 2, The orbicularis palpebrarum. 3, The levator labii superioris alæque nasi. 4, The zygomaticus major. 5, The zygomaticus minor. 6, The masseter. 7, The orbicularis oris. 8, The depressor labii inferioris. 9, The platysma myodes. 10, The deltoid. 11, The pectoralis major. 12, The latissimus dorsi. 13, The serratus major anticus. 14, The biceps flexor cubiti. 15, The triceps extensor cubiti. 16, The supinator radii longus. 17, The pronator radii teres. 18, The extensor carpi radialis longior. 19, The extensor ossis metacarpi pollicis. 20, The annular ligament. 21, The palmar fascia. 22, The obliquus externus abdominis. 23, The linea alba. 24, The tensor vaginæ femoris. 26, The psoas magnus. 27, The adductor longus. 28, The sartorius. 29, The rectus femoris. 30, The vastus externus. 31, The vastus internus. 32, The tendon patellæ. 33, The gastrocnemius. 34, The tibialis anticus. 35, The tibia. 36, The tendons of the extensor communis.

Fig. 80. A posterior view of the muscles of the body. 1, The temporalis. 2, The occipito-frontalis. 3, The complexus. 4, The splenius. 5, The masseter. 6, The sterno-cleido-mastoideus. 7, The trapezius. 8, The deltoid. 9, The infra-spinatus. 10, The triceps extensor. 11, The teres minor. 12, The teres major. 13, The tendinous portion of the triceps. 14, The anterior edge of the triceps. 15, The supinator radii longus. 16, The pronator radii teres. 17, The extensor communis digitorum. 18, The extensor ossis metacarpi pollicis. 19, The extensor communis digitorum tendons. 20, The olecranon and insertion of the triceps. 21, The extensor carpi ulnaris. 22, The auricularis. 23, The extensor communis. 24, The latissimus dorsi. 25, Its tendinous origin. 26, The obliquus externus. 27, The gluteus medius. 28, The gluteus magnus. 29, The biceps flexor cruris. 30, The semi-tendinosus. 31, 32, The gastrocnemius. 33, The tendo-Achilles.

## THE FASCIÆ.

Fasciæ are laminæ, or membranes of various extent and thickness, distributed through the different regions of the body, for the purpose of investing and protecting the softer and more delicate organs. An instance is seen in the membrane which envelopes a leg of beef, and which is observed on the edges of the slices when it is cut for broiling. When freshly exposed, it is brilliant in appearance, tough and inelastic. In the limbs, it forms distinct sheaths to all the muscles and tendons. It is thick upon the outer and least protected side of the limb, and thinner upon its inner side. It is firmly connected with the bones, and with the prominent parts of each region, as the pelvis, knee, and ankle, in the lower, and the clavicle, scapula, elbow, and wrist, in the upper extremity. It assists the muscles in their action, by keeping up a tonic pressure on their surface. It aids materially in the circulation of the fluids in opposition to the laws of gravity. In the palm of the hand and sole of the foot, it is a powerful protection to the structures that enter into the formation of these regions.

In all parts of the system, the separate muscles are not only invested by fasciæ, but they are arranged in layers, one over another. The sheath of each muscle is loosely connected with another, by the cellular membrane.

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*Define fasciæ.* Where are they distributed? For what purpose? How are the muscles invested? How are they arranged in regard to each other? With what is the sheath of each muscle connected?

Fig. 81.

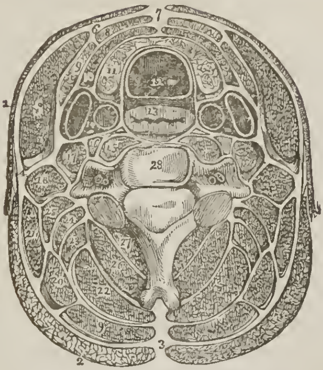

**Fig. 81. Represents a transverse section of the neck. The separate museles, as they are arranged in layers, with their investing fasciæ, are beautifully represented. As the system is symmetrical, figures are placed only on one side.**

**1, Is the muscle that forms the external layer upon the anterior part of the neck, separated from the second layer of muscles, 5 and 8 by a fascia, represented at 6. The third layer is seen at 9 and 10, separated by a fascia from the second layer, and also from the fourth layer, seen at 11. 12, The trachea. 13, The œsophagus. 14, The carotid artery and jugular vein. 2, The muscle that constitutes the exterior layer of muscles upon the back part of the neck, separated from the second layer of muscles, seen at 19, 20, 21, by the fasciæ, 3, 4. The third layer of muscles, 22, 23, 24, 25, is separated from the second layer by a fascia, and also from the fourth layer, seen at 26. The fifth layer, at 27, separated from the fourth by a fascia, like the other muscles. 28, Is one of the cervical vertebra. In the trunk the muscles are arranged in layers, surrounded by fasciæ, as in the neck. The same is true of the muscles of the upper and lower limbs.**

## PHYSIOLOGY OF THE MUSCULAR SYSTEM.

The peculiar characteristic of muscular fibres is *contractility*, or the power of shortening their substance on the application of stimuli, and again relaxing, when the stimulus is withdrawn. This is illustrated in the most common movements of life. Call into action the muscles that elevate the arm, by the influence of the will or mind, (the common stimulus of the muscles,) and the arm and hand are raised; withdraw this influence by a simple effort of the will, and the muscles, before rigid and tense, become relaxed and yielding.

The contractile effect of the muscles in producing the varied movements of the system may be seen in the bending of the elbow. The tendon of one extremity of the muscle is attached

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What does Fig. 81 represent? What is the peculiar characteristic of muscular fibres?

to the shoulder bone, which acts as a fixed point; the tendon of the other extremity is attached to one of the bones of the fore-arm. When the belly of the muscle contracts or shortens, its two extremities approach nearer each other, and by the approximation of the terminal extremities of the muscle, the joint at the elbow bends. On this principle, all the joints of the system are moved. This is illustrated in fig. 82. When the fibres of a muscle contract, while the two extremities are brought nearer each other, the contracted part of it or belly becomes fuller and harder.

The muscles exercise great influence upon the system. It is by their contraction that we are enabled to pursue different employments. By their action the farmer cultivates his field, the mechanic wields his tools, and the author his pen, the sportsman pursues his game, the orator gives utterance to his thoughts, the lady sweeps the keys of the piano, and the young are whirled in the mazy dance. As the muscles bear so intimate a relation to the pleasures and employments of man, a knowledge of the laws by which their action is governed, and the conditions upon which their health depends, should be possessed by all.

Fig. 82.

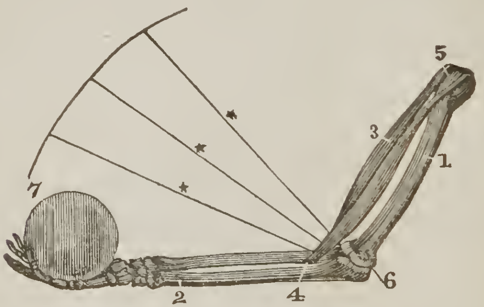


Fig. 82. 1, The humerus, or first bone of the arm. 2, One of the bones of the fore-arm, to which the muscle (3,) that bends the elbow, is attached at 4. 5. The attachment of this muscle to the humerus, at its upper extremity. 6, The elbow joint. 7, A weight in the hand, to be elevated by the contraction of the muscle seen at 3; as the bones of the fore-arm (2,) are brought to the lines indicated by ***, the belly of the muscle (3) contracts, and its two ends are brought nearer together.

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How is the elbow bent? By the agency of what part of the system is every movement effected? Why is it important that every individual should know the laws on which the health of the muscles depends?

## PRACTICAL SUGGESTIONS.

In order that the size of muscles may be adequate to the power demanded of them, it is necessary that, —

1st. *The muscles should be used with alternate rest.* It is a law of the system that the action and power of an organ are commensurate, to a certain extent, with the demand made upon it, and it is a law of nature that whenever a muscle is called into frequent use, its fibres increase in thickness within certain limits, and become capable of acting with greater force; while, on the contrary, the muscle that is little used, decreases in size and power. Hence, every appendage to the dress of ladies which prevents free motion of the muscles of the chest and spine, weakens the muscles thus restrained, and not only prevents the proper expansion of the lungs, but by weakening the muscles which sustain the spine, induces curvature and disease. Whalebone, wood, steel, and every other unyielding substance should be banished from the toilet as enemies of the human race.

The reason why action increases the size of the muscles is obvious when we recollect that arterial blood is supplied to every organ of the system, in proportion to the extent and energy of its action. On the other hand, when an organ is not duly supplied with nutrient blood, it becomes enfeebled, and gradually loses its power of action. Compare the arm of the smith, who works at the anvil, with the limb that has been supported in a sling; the arm of the one will be found large and firm, while that of the other is small and soft. In the one, the action of the vessels is energetic; in the other sluggish.

Let the inactive boy and girl, or gentleman and lady, remember this, when complaining of want of strength, loss of appetite, depressed spirits, — when they are seeking some sovereign remedy for their complaints, — apparently unmindful that God, in his infinite benevolence, has adapted the bones and muscles to action. For sedentary persons, that kind of exercise is best which brings into action the greatest

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What is the first condition? What results follow the restriction of the muscles of the chest and spine? Why does action increase the size of the muscles? What comparison is made? What advice is given to those of indolent habits? What exercise is best for sedentary persons?

number of muscles. Hence, for school-girls, jumping the rope is an excellent exercise, especially if it can be practised in the open air; but this exercise cannot be taken with safety, if the young girl persist in wearing the apparel tight around the lower part of the chest.

2d. *The muscles should not be compressed.* Compression prevents the blood from passing to those parts with freedom; consequently, they are not supplied with material to renovate them and promote their growth. Again, pressure stimulates the absorbents to action; by the increased activity of these vessels, the muscles are attenuated. In the case of a man with a fractured limb, the muscles are not only enfeebled by inaction, but diminished in size, by compression from the dressing. Limbs enfeebled in this way will not recover their size, tone, and strength, until the bandages have been removed, and a proper amount of exercise has been taken. The pressure of tight dresses, under the name of a "snug fit," enfeebles the muscles of the back, and is a common cause of projecting shoulders and curvatures of the spine.

3d. *Muscles should be abundantly supplied with pure blood.* The following conditions are essential to this state of the blood, namely, a healthy state of the digestive organs, a proper quantity and quality of food, taken at due intervals, and when the system is in a condition to digest aliment. (See chapter on Digestive Organs.) Purity of blood also requires attention to the skin. It should be kept warm by proper clothing, clean by bathing, and be acted upon by pure air and good light. (See chapter on the Skin.) As the blood is oxydated and divested of a portion of impurity in the lungs, they should have ample volume, possess good health, and be supplied with pure air. The movements of the ribs and diaphragm should be unrestricted. (See chapter on the Lungs.)

In all instances, muscular power is greatest when the foregoing conditions exist; consequently, it is of practical importance to the laboring mechanic, the industrious agriculturist, the man of leisure, and not less so to the ladies, whatever avocation of life they pursue, to observe them.

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What is the second condition? Why is compression of a muscle injurious? What is another reason for muscles becoming attenuated? What is a common cause of projecting shoulders and curved spines? What is the third condition? When is muscular power greatest?

Fig. 83. Fig. 84.

Fig. 84. The erect and correct position for standing is represented. Fig. 83. The stooping and deformed position is illustrated. This deformity can be corrected if the youth will frequently practise throwing the shoulders back, and walk, as well as stand erect. Pupils while standing during recitations, often inadvertently assume the leaning attitude, and it is the duty of teachers to correct this position when assumed.

4th. The attitude of children in standing has been much neglected both by parents and teachers. Let the stooping posture be acquired in youth, and we are quite certain of seeing the stooping shoulder in old age. Hence, the importance of duly exercising the muscles of the back; for when they are properly developed the child can stand erect. In this attitude the shoulders will be thrown back, and the chest will become broad and full. But, on the contrary, let the youth acquire the habit of inclining his head and shoulders, and the chest will become contracted, the muscles of the back enfeebled, and the deformity thus acquired will progress to advanced age.

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Have the attitudes of children been neglected? Why should a child be taught to stand erect?

Fig. 85.

Fig. 85. Represents the proper and physiological position in sitting.

The position of a child or an adult, when sitting, conduces to a healthy or unhealthy condition of the system. The child should be taught to sit erect when employed in study or work, as this attitude favors a healthy action of the various organs of the system, and conduces to beauty and symmetry of form.

Scholars are more or less inclined to lean forward and place the elbow on the table or desk, for support; and this is often done when their seats are provided with backs. Where there is a predisposition to curvature of the spine, no position is more unfavorable or more productive of deformities than this, for, it is usually continued in one direction, and the apparent deformity it induces is a projection of the shoulders. If the girl is so feeble that she cannot sit erect, as represented in fig. 85, let her stand, or recline on a couch; either is preferable to the position represented in fig. 86.

In furnishing school-rooms care should be taken that the

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Why should a child sit erect? What is the effect of the leaning attitude? Design of figures 83, 84, 85, 86? If the girl be so feeble that she is unable to sit erect, what attitudes are preferable?

seats for the scholars are provided with appropriate backs, and the desks should not be so low as to compel them to lean forward in examining their books.

Fig. 86.

5th. Relaxation must follow contraction, or in other words, rest must follow exercise. This is a fundamental law of the muscular system. The necessity of relaxation, when a muscle has been called into action, is seen in the example of a boy extending his arm with a book in his hand, as a punishment. The boy can keep the arm extended but a short time, make what effort he may. It is also seen in the restlessness and feverish excitement that are evinced by persons gazing on troops during days of review. The same is noted in shopping. Such employments call into action the muscles that support the spinal column in an erect position. This languor, or uneasiness, is muscular pain. The long-continued tension and stretching of a muscle enfeeble its action, and eventually destroy its contractility.

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What should be done in furnishing school-rooms? What is the fundamental law of the muscular system? Give examples of the necessity of relaxing the muscles.

In school, the small children, after sitting a short time, become restless. If their position be changed, their imperfectly developed muscles will acquire tone, and will again support the spinal column erect without pain. Compelling children to sit erect for a long time, is an evil practice; for it is a violation of the muscular law, and too frequently produces the lateral curvature of the spine and projecting shoulder.

Fig. 87.

In cases of projecting shoulders, as here represented (fig. 87), there is uniformly curvature of the spinal column.

The necessity of frequent intermissions or recesses in school is founded on the organic law of muscular action, alternating with rest.

The younger and more feeble pupils are, the greater the necessity for frequent recesses. We would not have the teacher think that one half of the time, at least, should be spent in giving the pupils intermissions; or the mother, that her daughter is going to school to play. But we maintain that recesses should be given; and that they should be short

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Why should not small children be confined in one position for a long time? What evils result from this practice? What class of pupils should have recesses most frequently?

and frequent for small and feeble scholars. If such were the practice, young misses would not complain of weakness in the spine and limbs and of a dislike for school.

Fig. 88.

Fig. 88. Represents the condition of the spine or back bone where projections of the shoulders are seen, or where one shoulder projects. In such cases, there is always a lateral curve of the spinal column; usually there are two, as seen above.
The ribs at the lower part of the chest hollow in, and on the other side they project. One hip likewise projects.

Exhaustion is the inevitable result of continued tension and muscular contraction. For example, let a lady ply the needle quickly for some hours, and the muscles of the back and right arm will become exhausted, which will be indicated by a sense of weariness in these parts. A change of employment and position calls into action a different set of muscles, and relieves the exhausted organs. Much more labor will be accomplished by taking time to relax the exhausted muscles, or by so changing the employment as to bring into action a new set of muscles; the woodman thus relieves himself, by sawing and

What effect has the continued tension of a muscle? Give an example from the exhaustion of the muscles.

splitting alternately. This principle applies to the labor of the horse and ox; and it is also applicable to all kinds of employment. A disregard of the laws of the muscles is attended with weighty consequences. With the invalid convalescing from fever, relapses result from inattention to these laws. When a patient is recovering from sickness, his physician should take care that his exercise be proper, neither too much, too little, nor too long continued.

6th. Every fibre of each muscle is connected with the brain, by white cords, that pass from its base and the spinal cord. Through the agency of these cords, called nerves, the brain imparts to the muscles a nervous influence, that induces contraction or action in them. Consequently, the health, activity, and size of the brain, spinal cord, and nerves, modify muscular action. If the brain be healthy, muscular action will be more efficient than if it were diseased. This is illustrated by the muscular prostration observed in typhus fever, apoplexy, inflammation of the brain, and intoxication. The cessation of the action of the muscles, while the brain is inactive, illustrates the influence that the nervous system exerts upon muscular energy. If the spinal cord, or the nerves distributed to any set of muscles, be destroyed, their contractility and sensibility will cease. Compression of the nerves, in any member of the system. destroys or impairs its sensibility or movements. The want of sensibility, and the diminished strength of the lower limbs, sometimes experienced after sitting upon a hard bench, are illustrations of the effects of compression of the nerves. In this instance the sciatic nerve, distributed to the leg, is compressed.

It has been observed among men of the same size, that a wide difference exists in their muscular strength and activity. This depends upon the size and number of the nerves, and the size and activity of the brain. Men having large nerves leading to the muscles, with the brain active, will perform feats of strength and agility, that other men, of the same size, cannot effect. Rope dancers, harlequins, and other perform-

What is one cause of relapse of fever? Is every fibre of each muscle connected with the brain? What is the medium of this connection? What circumstances modify muscular action? State cases in which muscular action will be inefficient. What effect has compression on the nerves? Give an example. On what does the difference in muscular activity and strength depend?

ers of feats, are persons thus constituted. Persons with small muscles, and largely developed nervous systems, will sometimes exhibit very great muscular power for a time, but it will not be of long continuance, unless the brain is functionally diseased, as in hysteria. Men of large muscles and small nerves, can never perform feats of great strength, but they have the power of endurance, and are better capacitated for continued labor. Thus we cannot judge of the ability of a person to make exertions and continue them, by their stature alone. Strength, and the power of endurance, are the result of the combination of well-developed muscles, large nerves, and a full-sized, healthy, and active brain.

Fig. 89.


Fig. 90.


Fig. 89. 1, A perpendicular line from the centre of the feet. 2, The spinal column with its natural curves. The lower limbs are straight, the body perpendicular, the shoulders thrown back, and the head erect. As the head and shoulders are posterior

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What is said of those persons who have small muscles, and largely developed nervous systems? Of those who have large muscles, and small nerves? Upon what do strength and the power of endurance depend?

to the perpendicular line (1) they balance the portion of the trunk anterior to the line. This erect position of the body and head is always accompanied with straight lower limbs. Here the body is balanced upon the spinal column and joints of the lower extremities, so that the muscles are not kept in a state of tension.

Fig. 90. 1, A perpendicular line from the centre of the feet. 2, Represents the unnatural curved spinal column and its relative position to the perpendicular, (1). The lower limbs are seen curved at the knee, and the body is stooping forward. While standing in this position the muscles of the lower limbs and back are in steady tension, which exhausts and weakens them.

7th. *A person whose position is erect, will stand longer, walk farther, and perform more labor, than an individual whose position is stooping, but equal in all other respects.* This arises from two circumstances. 1st. To maintain a muscle in a state of contraction, an influence is transmitted to it from the brain. The fewer the muscles in a state of tension, the less the draught upon the nervous system, and the less its exhaustion. In an erect position, the trunk and head are balanced upon the bones and cartilages of the spinal column.

If the body slightly incline forward, the muscles attached to the posterior side of the spine, by a gentle contraction, will bring it to the perpendicular and even incline it backwards. This is immediately removed by a slight contraction of the muscles upon the anterior side of the spinal column. Consequently, in the erect position, there is constant slight oscillation of the body backwards and forwards, like the movement of a pendulum; while, in the stooping posture, the muscles on the posterior side of the spinal column are kept in a state of continued tension and contraction, to prevent the body from falling forwards. This enfeebles the muscles of the back and exhausts the nervous energy, while the erect position favors their development and powers, as contraction alternates with relaxation.

2d. When it is necessary to call into action a portion of the muscles of the system in the performance of any duty, as those of the lower limbs in walking, if the muscles of other parts are in a state of inaction, the influence of the nervous system can be determined in an undivided manner upon those parts of the lower limbs in action; hence, they will not so soon become wearied or exhausted, as when this influence is divided between a greater number of muscles. In performing any labor, as in speaking, reading, singing, mowing, sewing, &c., there will be less exhaustion, and the effort can be

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Give the reasons why a person who stands erect will walk farther, and perform more labor than if he assumed the stooping posture.

longer maintained in the erect position of the body and head, than in the stooping position, and for the before-mentioned reasons.

The same principle applies to the position in sitting; let a person incline forward, and the muscles upon the back are brought into a state of tension, which exhausts and enfeebles the nervous system in a greater degree, than if the erect attitude was assumed.

8th. *The mind exerts a great influence upon the tone and contractile energy of the muscular system.* A person acting under a healthy mental stimulus, will make exertion with less fatigue than he would without this incentive. For an illustration, a sportsman will pursue his game miles without fatigue, while his attendant, not having any mental stimulus, will become weary. Again, let him spend some hours in pursuit of his favorite game without success — a feeling of languor creeps over him; but while he is thus fatigued and dispirited, let him catch a glimpse of the game, — his wearied feelings are immediately dissipated, and he presses on with renewed energy and recruited strength.

This principle was well illustrated in the retreat from Russia of the defeated and dispirited French army. When no enemy was near, they had hardly strength sufficient to carry their arms; but no sooner did they hear the report of the Russian guns, than new life seemed to pervade them, and they wielded their weapons powerfully, until the foe was repulsed; then, there was a relapse to weakness, and prostration followed. It is thus with the invalid when riding for his health; — relate an anecdote, or excite this mental stimulus by agreeable conversation, and much benefit will accrue from the ride to the debilitated person. So it is in the daily avocations of life; if the mind have some incentive, the tiresomeness of labor will be greatly diminished. Let an air of cheerfulness ever pervade our every employment, and, like music, "it sweetens toil."

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Why can a person perform more labor and sit longer, when the posture is erect, then when inclined? Does the mind have any influence upon muscular contractility? Give an illustration of mental stimulus coöperating with muscular activity in the case of a sportsman. Give an illustration of mental stimulus coöperating with muscular activity in the case of the dispirited French army, in their retreat from Russia. Can a union of mental impulse and muscular action be beneficial to an invalid? How? Does the same principle apply to those who labor?

Facts illustrative of the inutility of calling the muscles into action, without the coöperation of the mind, are seen in the spiritless aspect of many of our boarding school processions, when a walk is taken merely for exercise, without having in view an attainable object. But present to the mind a botanical or geological excursion, and the saunter will be exchanged for the elastic step, — the inanimate appearance, for the bright eye and glowing cheek. The difference is simply, that in the former case, the muscles are obliged to work without that full nervous impulse so essential to their energetic action; and that, in the latter, the nervous influence is in full and harmonious operation.

It must not, however, be supposed that a walk simply for the sake of exercise can never be beneficial. Every one, unless prevented by disease, should consider it duty to take exercise every day in the open air; if possible, let it be had in combination with harmonious mental exhilaration; if not, let a walk be made so brisk as to produce rapid respiration and circulation of the blood, and in a dress that shall not interfere with free motions of the arms and free expansion of the chest.

9th. When the muscles have been exhausted by severe and long-continued exercise, or the brain and nervous system by protracted mental effort, the muscles are unfitted to maintain the system erect in standing or sitting for a considerable time, as the nervous system, in its exhausted state, cannot supply a sufficient amount of its peculiar influence to maintain the supporting muscles of the body and head in a state of contraction. Hence, a child or adult, when exhausted, as above described, should not be compelled to stand or sit erect in one posture, but should be permitted to vary the position frequently, as this rests and recruits both the muscular and nervous system. Attention to this fact and to the practice of bathing and applying friction to the limbs after violent exercise, particularly when an undue amount of unaccustomed exertion has been made, would prevent much of the stiffness and soreness so frequently experienced.

10th. *Upon the training or education of the muscles*, in a measure, depends the power of giving different intonations in

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Give an instance of the different effects produced by the absence and presence of the mental stimulus. Upon what does the power of giving different intonations in reading and speaking depend?

reading, speaking, and singing. The varied and rapid executions in penmanship, and all mechanical and agricultural employments are also dependent upon the training of the muscles. It is by having control over this part of the system, that efficiency is attained in any art. As muscular contraction is effected by a stimulus from the brain through the agency of the nerves, to produce this steady and effective contraction of the fibres, these organs, viz: the brain and nerves, should be healthy. In the first effort of muscular education, the contraction of the muscular fibres is irregular and feeble, as may be seen when the child begins to walk, or in the first efforts at penmanship. Repeated efforts render the muscular contraction obedient to the will.

In writing, two things are necessary, viz: To acquire the form of the letter, and the power of making it. The first is attained by inspection of the letter. The second is accomplished by calling into action the muscles that move the arm, hand and fingers. To make letters of a given form, the muscles must be educated to contract and relax steadily and harmoniously.

To effect this, the muscles should not be rigid, but relaxed, so as to be at the command of the will. A violent and rigid contraction of the large muscles that bend and extend the arm, hand, and fingers, very much lessens, or entirely prevents the lateral movements of these parts, which are produced by the action of much smaller muscles. See Figs. 66, 67, 68, 69, 70, 71, and 72.

Let any person call into vigorous action the muscles that bend and extend the hand, and he will find its lateral movements more difficult and much restricted. Again, rigidly extend the fingers by a vigorous contraction of the muscles upon the lower part of the arm, and the lateral movement of the fingers seen in their separation, cannot be made. A similar restriction attends the oblique movements of these parts when the large muscles are called into energetic action.

These lateral and oblique movements are essential to ease, freedom, and rapidity of writing. Consequently, the relaxed

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Through the action of what agency is every mechanical movement made? When a child begins to walk, why are its steps so irregular? What two things are requisite in penmanship? How can the second be effected? What results from having the large muscles that bend and extend the arm rigidly contracted?

state of the muscles of the arm, hand, and fingers, is essential to learning the art of writing with elegance and rapidity. When the arm, hand, and fingers are rigid, a set of muscles, viz: the large ones that bend and extend these parts, are called into too intense action. This requires of the small muscles that produce the lateral movements, an effort which they cannot make, or can with difficulty accomplish.

To a deficient analysis of the movements of the arm, hand, and fingers, on the part of teachers and pupils in penmanship, is to be ascribed the great want of success in acquiring this art. The pen should be held loosely, for the reasons given above, but always in the proper position. When thus held, the scholar should make an effort to imitate some definite copy as nearly as possible. The movements of the fingers, hand and arm, necessary to accomplish this, should be made with ease and rapidity, as is the case when a pupil writes with a pencil upon a slate, — striving, at each effort, to imitate the copy more nearly.

In order to train or educate the muscles in mowing, dancing, singing, playing the piano, and learning mechanical trades, or anything else, the muscles of the parts called into action must be relaxed, so as to be under the control of the will. Let the work be done as correctly as possible, at the first trial. Let there be judicious repetition, and soon the muscles will act readily and harmoniously in obedience to mental influence.

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Why have so many pupils failed in acquiring elegant penmanship? In educating the muscles what should be the first trial?

# CHAPTER VI.

## THE DIGESTIVE ORGANS.

THE ABDOMEN is the inferior or lower cavity of the trunk of the body. It is bounded in front and at the sides by the lower ribs and abdominal muscles, behind by the spinal column and abdominal muscles, above by the diaphragm, and below by the pelvis. It contains the organs subservient to digestion, namely, the stomach, the intestines, the liver, the pancreas, the spleen, and the organs of excretion.

### ANATOMY OF THE DIGESTIVE ORGANS.

The digestive organs are divided into the *jaws, salivary glands, mouth, pharynx, œsophagus, stomach, small and large intestines, lacteals, thoracic duct, liver, spleen, and pancreas.*

The JAWS have been described in the chapter on the bones. (See page 67.)

The SALIVARY GLANDS are six in number; three on each side. They are named the *parotid,* the *submaxillary,* and the *sublingual.*

The parotid gland, the largest, is situated in front of the external ear, and behind the angle of the jaw. A duct from this gland, named Steno's, opens into the mouth, opposite the second molar tooth of the upper jaw.

The submaxillary gland is situated within the lower jaw, anterior to the angle. Its excretory duct, (Wharton's,) opens into the mouth by the side of the frænum, or bridle of the tongue.

The sublingual gland is elongated and flattened, and situated beneath the mucous membrane of the floor of the mouth,

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Where is the abdomen situated? How is it bounded? What does it contain? *Name the organs that aid the process of digestion.* Name the salivary glands. Describe the parotid gland. Where is the submaxillary gland situated? Describe the sublingual gland and its situation.

on each side of the frænum linguæ. It has seven or eight small ducts, which open into the mouth by the side of the bridle of the tongue.

Fig. 91.


Fig. 91. A view of the salivary glands, in their proper situations. 1, The parotid gland. 2, The duct of Steno. 3, The submaxillary gland. 4, Its duct. 5, The sublingual gland, brought to view by the removal of a section of the lower jaw.

The MOUTH is an irregular cavity, which contains the instruments of mastication and the organs of taste. It is bounded in front by the lips; on each side by the internal surface of the cheeks; above by the hard palate and teeth of the upper jaw; below by the tongue and teeth of the lower jaw; behind by the soft palate and fauces.

The PHARYNX, from the Greek, *pharugx*, the swallow, is a muscular membranous sac, situated upon the upper portion of the spinal column. It extends from the base of the skull to the top of the trachea or wind-pipe. It is composed of muscular and mucous membranes, blood-vessels and nerves. The posterior nares, or nostrils, open into the upper and front part of the pharynx. Beneath the posterior nares, partly veiled by the soft palate, is a large opening into the mouth,

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How many ducts has the sublingual gland and where do they open? Describe Fig. 91. Describe the mouth. Describe the pharynx. Of what is it composed? What is said of its anterior part? Its posterior?

and beneath the root of the tongue, the opening into the larynx. The pharynx terminates in the œsophagus.

Fig. 92.

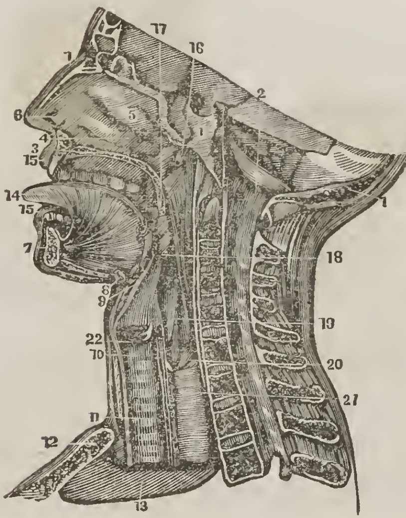


Fig. 92. A view of the muscles of the tongue, palate, larynx, and pharynx, as well as the position of the upper portion of the œsophagus, as shown by a vertical section of the head. 1, 1, 1, The vertical section of the head. 2, Points to the spinal canal. 3, Section of hard palate. 4, The inferior spongy bone. 5, The middle spongy bone. 6, The orifice of the right nostril. 7, Section of the lower jaw bone. 8, Section of the hyoid bone. 9, Section of the epiglottis. 10, Section of the cricoid cartilage. 11, The trachea. 12, Section of the sternum. 13, Inside of the upper portion of the thorax. 14, The tongue. 15, 15, The upper and lower lips. 16, The orifice of the eustachian tube. 17, Section of the soft palate and uvula. 18, The upper portion of the pharynx. 19, The lower portion of the pharynx. 20, 21, The œsophagus. 22, The vocal ligaments.

The ŒSOPHAGUS, from the Greek *oiô*, I carry, and *phagô*, I eat, is a winding canal that commences at the fifth cervical vertebra, behind the cricoid cartilage. It descends the neck, between the trachea and cervical vertebræ. In the thorax it lies before the thoracic aorta. It passes through the diaphragm, and terminates at the cardiac orifice of the stomach. It is composed of three coats, and is supplied with arteries, veins and nerves.

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Where does the pharynx terminate? Describe Fig. 92. Describe the œsophagus. How many coats or membranes has the œsophagus?

Fig. 93.

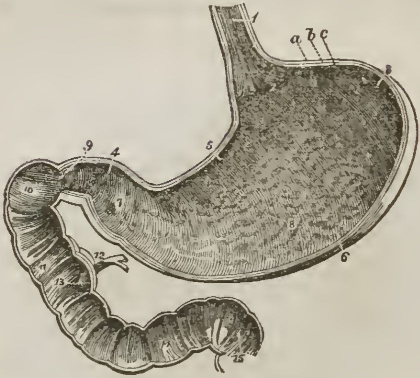


Fig. 93. A vertical and longitudinal section of the stomach and duodenum, made in such a direction as to include the two orifices of the stomach. 1, The œsophagus, upon the internal surface of which the follicated arrangement of the mucous coat is shown. 2, The cardiac orifice of the stomach, around which the fringed border of the mucous membrane is seen. 3, The great end of the stomach. 4, Its lesser or pyloric end. 5, The lesser curve. 6, The greater curve. 7, The dilatation at the lesser end of the stomach. This may be regarded as the rudiment of a second stomach. 8, Folds, lying in a longitudinal direction, formed by the mucous membrane. 9, The pylorus. 10, The oblique portion of the duodenum. 11, The descending portion. 12, The pancreatic duct and the ductus choledochus, close to their termination. 13, The papilla, upon which the ducts open. 14, The transverse portion of the duodenum. 15, The commencement of the jejunum. In the interior of the duodenum and jejunum the valvulæ conniventes are seen. *a*, The external coat. *b*, The middle coat. *c*, The inner coat.

The STOMACH is situated in the left side, immediately below and in contact with the diaphragm. Its small extremity extends into the epigastric region, below the left lobe of the liver. It has two curvatures, the great and the small; and two openings; one connected with the œsophagus, named the cardiac orifice; the other connected with the duodenum, named the pylorus, or pyloric orifice. In shape it is curved, like the Scotch bagpipe. It is composed of three coats or membranes; the exterior coat, named the serous, is a part of the peritoneum; the middle coat, named the muscular, is composed of two layers of muscular fibres, one set of which is arranged longitudinally, the other circularly. The interior coat is

Describe Fig. 93. Where is the stomach situated? How many curvatures has it? How many orifices? Where is the cardiac orifice? The pyloric? What is the form of the stomach? How many membranes has it? Describe each coat or membrane. Where is the mucous secreted?

named the mucous, and is arranged in rugæ, or folds. In this membrane are seen follicles, in which the mucous, that protects the membrane, is secreted. The stomach is provided with a multitude of minute glands, in which is secreted the gastric fluid or solvent.

The small intestines are about twenty-five feet in length, and are divisible into three portions, namely, the *duodenum*, the *jejunum*, and the *ileum*.

Fig. 94.

Fig. 95.

Fig. 96.

Fig. 94. Represents a portion of the mucous membrane of the stomach, showing the entrances of the secreting tubes or follicles upon its surface.
Figs. 95, 96. Represent glands from different sections of the stomach, from which gastric juice is secreted. They are magnified forty-five diameters.

The DUODENUM is somewhat larger than the rest of the small intestines, and has received its name from being in length about the breadth of twelve fingers. It commences at the pylorus, and ascends obliquely backward to the under surface of the liver. It then descends perpendicularly in front of the right kidney, and passes transversely across the third lumbar vertebra, and terminates in the jejunum. The ductus choledochus communis and pancreatic duct open into the perpendicular portion, a little below its middle.

The JEJUNUM forms the upper two-fifths of the small intestines. It commences in the duodenum, and terminates in the ileum. It is thicker than the rest of the intestines, and has a pinkish tinge.

The ILEUM includes the remaining three-fifths of the small intestines. It is somewhat paler, smaller, and thinner in texture than the jejunum. There is no mark to distinguish

What other secretion in the stomach? What do Figs. 94, 95, and 96 represent? What is the length of the small intestines? How divided? What is said in regard to the duodenum? Where do the pancreatic and choledochus ducts open? What is said of the jejunum? Its color? What is said of the ileum?

the termination of the one, or the commencement of the other. The ileum terminates in the right iliac fossa, by opening into the colon, at an obtuse angle. This opening is called the ilio-colic valve, as it prevents the passing of substances from the colon into the ileum. The jejunum and ileum are surrounded above and at the sides by the colon.

The small intestines have three membranes or coats; the outer or serous, the middle or muscular, and the internal or mucous coat. This last is thrown into folds or valves, named the valvulæ conniventes. In consequence of this valvular arrangement, the mucous membrane is more extensive than the other tissues, and gives a greater extent of surface with which the aliment comes in contact.

Fig. 97.

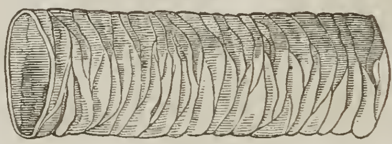

Fig. 97. Represents the valvulæ conniventes of the internal surface of the small intestines.

There are embedded under the mucous membrane an immense number of minute glands, named the glands of Peyer and Brunner. There are, likewise, upon the mucous coat, an immense number of piles, like those upon velvet; hence this membrane is named the villous coat.

The LACTEALS are minute vessels, which commence in the villi, upon the mucous surface of the small intestines. From the intestines, they pass between the membranes of the mesentery to small glands, which they enter. The first range of glands collects many small vessels, and transmits a few larger branches to a second range of glands. From the second range, the lacteals, diminished in number and increased in size, proceed to the enlarged portion of the thoracic duct, named the receptaculum chyli, into which they open.

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Can the precise termination of each be distinguished? By what are they surrounded? How many coats or membranes have the small intestines? How are the valvulæ conniventes formed? What are the lacteals? What is said of the first range of glands? Of the second?

The THORACIC DUCT commences in the abdomen, by a considerable dilatation, named the *receptaculum chyli*, which is situated upon the front of the body of the second lumbar vertebra. From this point, it passes through the diaphragm, and ascends to the fourth dorsal vertebra. It there lies anterior to the spine, and by the side of the aorta. It then inclines to the left, behind the arch of the aorta, and ascends by the side of the œsophagus, to the seventh cervical vertebra, where it makes a sudden turn downward and forward, and terminates by opening into the vein at the junction of the left subclavian, and left internal jugular vein. The thoracic duct is equal in diameter to a goose-quill, and, at its termination, is provided with a pair of semilunar valves, which prevent the admission of venous blood into its cylinder.

Fig. 98.

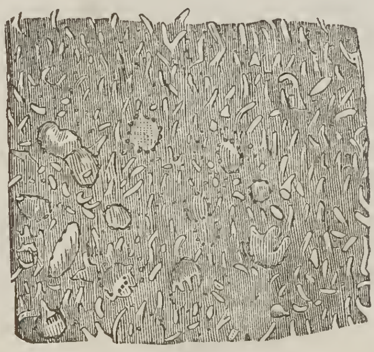

Fig. 98. Represents the small glands of the intestines, that lie under the mucous coat. They are represented highly magnified. The villi are also displayed.

The large intestine, about five feet in length, is sacculated in appearance, and divided into the *cœcum*, *colon*, and *rectum.*

The CŒCUM is the blind pouch, or cul-de-sac, at the commencement of the large intestine. Attached to its extremity is the *appendix vermiformis,* — a long, worm-shaped tube. It is from one to six inches in length, and of the diameter of a goose-quill.

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Describe the course of the thoracic duct. What is its size? How is the venous blood prevented from passing into this duct? Describe the cœcum?

Fig. 99.

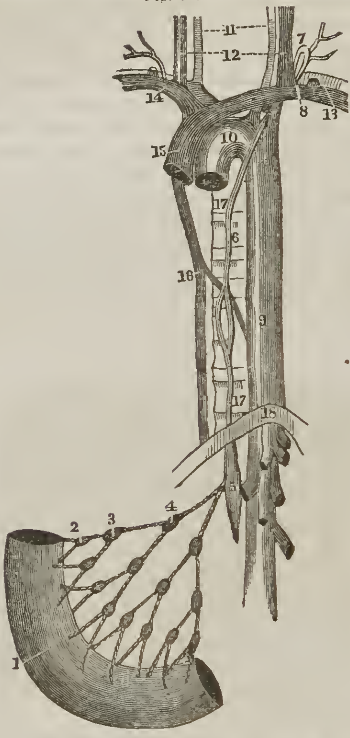


Fig. 99. A section of the small intestines, lacteal vessels, and glands, with the thoracic duct. 1, The intestine. 2, 3, 4, Mesenteric glands. Lacteal vessels pass from the intestines to the gland, 2; from 2 to 3; from 3 to 4; and from 4 to 5, the commencement of the thoracic duct. 6, The trunk of the thoracic duct. 7, The point at the lower part of the neck, where the duct turns downward to enter the transverse vein at (8.) 9, The descending aorta. 10, The arch of the aorta. 11, The carotid arteries. 12, The jugular veins. 13, The subclavian artery. 14, The subclavian vein. 15, The descending vena cava. 16, The azagos vein. 17, 17, The spinal column. 18, The diaphragm.

The COLON is divided into three parts; the *ascending*, the *transverse*, and the *descending*. The ascending colon passes upwards from the right iliac fossa, to the under surface of the liver. It then bends inwards, and crosses the upper part of the abdomen, below the liver and stomach, to the left side,

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How is the colon divided? Describe the ascending colon. The transverse.

under the name of transverse colon. At the left side it turns and descends to the left iliac fossa, and is called the descending colon. Here it makes a peculiar curve upon itself, which is called sigmoid flexure.

The RECTUM is the termination of the large intestines.

Fig. 100.

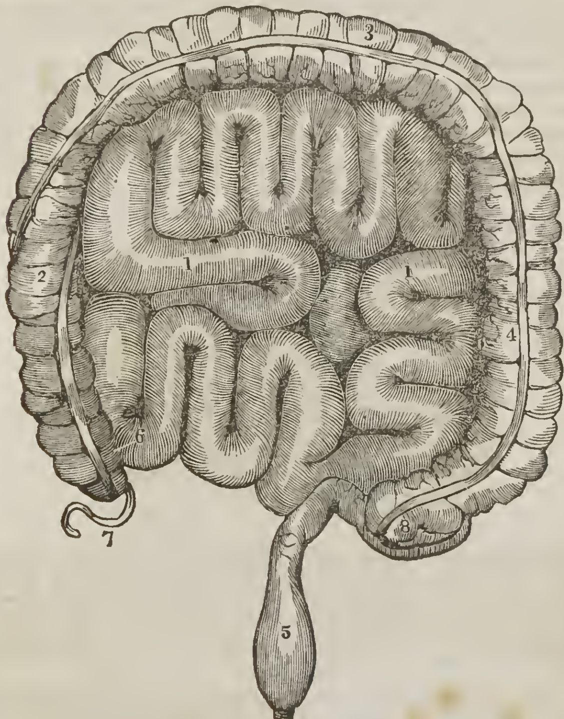


Fig. 100. 1, 1, The small intestines 2, The ascending colon. 3, The transverse colon. 4, The descending colon. 5, The rectum. 6, The junction of the small with the large intestines. 7, The appendix vermiformis. 8, The sigmoid flexure of the colon.

The large intestines have three coats; the external, or serous; the middle, or muscular; and the internal, or mucous.

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The descending. Where is the rectum situated? What does Fig. 100 represent? How many coats have the large intestines?

The longitudinal fibres of the muscular coat are collected into three bands. These bands are nearly one half shorter than the intestine, and give it a sacculated appearance, which is characteristic of the cœcum and colon.

The LIVER, a gland appended to the alimentary canal, is the largest organ in the system, and weighs about four pounds. It is situated in the right side, below the diaphragm, and is composed of several lobes. It is retained in its place by several ligaments. Its upper surface is convex; its under, concave. It performs the double office of separating impurities from the venous blood, and of secreting a fluid necessary to chylification, viz: the *bile*. The bile is conveyed, by the ductus choledochus communis, into the *duodenum* — not into the *stomach*.

Fig. 101.

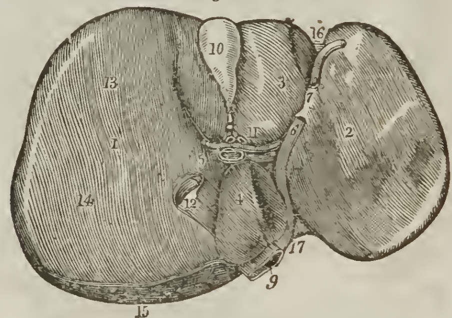


Fig. 101. Represents the under surface of the liver. 1, The right lobe. 2, The left. 3, 4, 5, Smaller lobes. 6, The longitudinal fissure, in which is seen the round ligament. 7, A portion of the liver forming a sort of bridge over this fissure. 9, The inferior vena cava. 10, The gall bladder lodged in its depression. 11, The transverse fissure, containing from before backwards, the hepatic duct, hepatic artery, and portal vein. 12, The vena cava. 13, A depression corresponding with a curve in the intestine. 14, Another depression produced by the right kidney. 15, The posterior edge of the liver. 16, The notch in the anterior border, separating the right and left lobes. 17, The notch on the posterior border, for the spinal column.

The PANCREAS is a long, flattened gland, analogous to the salivary glands. It is about six inches in length, weighs three or four ounces, and is situated transversely across the posterior wall of the abdomen, behind the stomach. A duct from this organ opens into the duodenum.

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What is characteristic of the cœcum and colon? Describe the liver. How is it retained in its place? What is its form? What office does the liver perform in the animal economy? Is the bile conveyed into the stomach? Describe the pancreas.

Fig. 102.

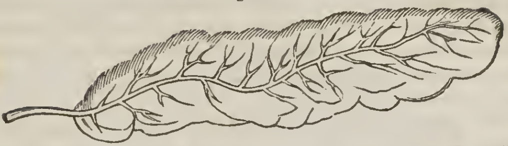

Fig. 102. Exhibits the pancreas with its duct, through which the pancreatic secretion passes into the duodenum.

The SPLEEN, so called, because the ancients supposed it to be the seat of melancholy, is an oblong, flattened organ, situated in the left side, in contact with the diaphragm, large extremity of the stomach, and the pancreas. It is of a dark, bluish color, and is abundantly supplied with blood, but has no duct which serves as an outlet for any secretion. Its use is not well determined.

Fig. 103.

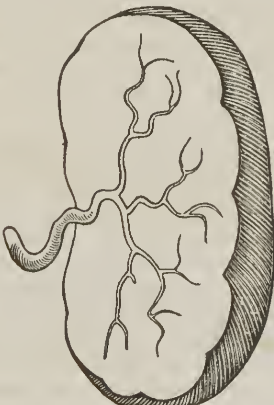

Fig. 103. Represents the form of the spleen; the splenic artery is seen entering and ramifying through the organ.

The OMENTUM, or *caul*, consists of four layers of the peritoneum, which descend from the stomach and transverse colon. A quantity of adipose matter is deposited around its

What is the form of the spleen? Why so called? Where is it situated? What is said of the omentum?

vessels, which ramify through its structure. It performs a double function in the animal economy. 1st. It protects the intestines from cold; and 2dly. It facilitates the movements of the intestines upon each other during their vermicular action.

Every part of the digestive apparatus is supplied with arteries, veins, absorbents, and nervous filaments from the ganglionic system of nerves.

## PHYSIOLOGY OF THE DIGESTIVE ORGANS.

The alimentary substances, which serve the purposes of nutrition, require to undergo a peculiar preparation, which is called *digestion*. All solid articles used for food, should be reduced to a state comparatively fine, by the action of the teeth upon them. While the food is in process of mastication, there is incorporated with it, a considerable amount of fluid, named *saliva*. This fluid is furnished by the salivary glands, situated in the vicinity of the mouth. The saliva moistens and softens the food, so that when carried into the pharynx, it is passed, with ease, through the œsophagus into the stomach.

Properly masticated food not only stimulates the coats of the stomach to a contractile effort, but it excites an action in the glands of the stomach. These glands secrete a fluid of great solvent power, named the *gastric juice*. The action of this fluid, aided by the contractile, muscular energy of the stomach, converts the various kinds of food into a homogeneous mass, of a pulpy consistence, which is named *chyme*.

The bile has no agency in the change through which the food passes in the stomach. In a healthy condition of this organ, no bile is found in it. The common belief, that the stomach has a redundancy of bile, is erroneous. If bile be ejected in vomiting, it merely shows, not only that the action of the stomach is inverted, but, also, that of the duodenum. A powerful emetic will, in this way, generally bring bile from

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Its use? With what is every part of digestive apparatus supplied? *Give the physiology of the digestive organs.* Should solid food be well masticated or chewed? What is mixed with the food when it is properly masticated? What is the use of the saliva? What do the glands of the stomach secrete? By what agency is the food converted into chyme? Has the bile any agency in the change of food in the stomach?

the most healthy stomach. A knowledge of this fact might save many a stomach from the evils of emetics, administered on false impressions of their necessity, and continued from the corroboration of these false impressions by the appearance of bile, till derangement and perhaps permanent disease are the consequences.

The chyme is conveyed through the pylorus, or pyloric orifice of the stomach, into the upper portion of the small intestine, named the duodenum. The chyme not only excites an action in the duodenum, but also in the liver and pancreas. *Mucus* is then secreted by the duodenum, *bile* by the liver, and *pancreatic fluid* by the pancreas. The bile and pancreatic fluid are conveyed into the duodenum, and mixed with the chyme. By the action of these different fluids, a portion of the chyme is converted into a fluid of a whitish color, which is named *chyle.*

The chyle and residual matter are moved over the mucous surface of the small intestine, by the action of its muscular coat. This movement is called peristaltic, or vermicular, from its resemblance to the movements of a worm. As the chyle is carried along the tract of the intestine, it comes in contact with the villi, where the lacteal vessels commence. These imbibe or take up the chyle, and transfer it through the mesenteric glands into the thoracic duct, through which it is conveyed into the large vein at the lower part of the neck. In this vein the chyle is mixed with the venous fluid, and the whole is called impure venous blood. The residual matter is conveyed into the cœcum, the first portion of the large intestine, and is the natural stimulant to produce healthy action of these organs. Food, therefore, must not be too *concentrated, or too rich,* but must contain waste matter. For this reason, coarse meal bread is better for general use, than fine flour bread, unless we daily take other food which contains waste materials. In the process of digestion, five different changes should be noticed. 1st. The chewing and admixture of the saliva with the food; this process is called *mastication.* 2d. The change, through which the food passes in the stomach

Through what orifice of the stomach does chyme pass? To what is the chyme then changed? By the action of what secretions is it changed into chyle? How is the chyle carried along the intestinal tract? As the chyle passes along the intestinal tract, how is it conveyed into the thoracic duct? What is the chewing of food called? Its change in the stomach?

by its muscular contraction, and the secretion from the gastric glands; this is called *chymification.* 3d. The conversion of the pulpy homogeneous chyme, by the agency of the bile and pancreatic secretions, into a fluid of milk-like appearance, called chyle; this is *chylification.* 4th. The absorption of the chyle by the lacteals, and its transfer through them and the thoracic duct, into the subclavian vein. 5th. The separation and excretion of the residuum.

### PRACTICAL SUGGESTIONS.

*It is a law of the system, that each organ is excited to healthy and efficient action, when influenced by its appropriate stimulus.* Accordingly, nutrient food that is adapted to the wants of the system, imparts a healthy stimulation to the salivary glands, during the process of mastication. The food that is well masticated, and has blended with it a proper amount of saliva, will induce a healthy action in the stomach, as this is its appropriate stimulus. Well-prepared chyme is the natural stimulus of the duodenum, liver, and pancreas; perfectly elaborated chyle is the appropriate excitant of the lacteal vessels.

Hence, if the processes of *mastication* and *insalivation* are defective, all the subsequent changes in the digestion of food will be imperfect. If *chymification* or *chylification* be faulty, the changes of the food in the ulterior digestive process will be incomplete.

Fig. 104. A view of the organs of digestion, opened nearly their whole length. A portion of the œsophagus has been removed. The arrows indicate the course of substances along the canal. 1, The upper lip, turned off the mouth. 2, Its frænum. 3, The under lip, turned down. 4, Its frænum. 5, 5, The inside of the cheeks. 6, 6, Point to the opening of the duct of Steno. 7, The roof of the mouth. 8, 8, The lateral half arches. 9, 9, Point to the tonsils. 10, The velum palati. 11, 11, The surface of the tongue. 12, Papillæ near its point. 13, A portion of the trachea. 14, 14, The œsophagus. 15, Its internal surface. 16, The inside of the stomach. 17, Its greater extremity. 18, Its lesser extremity. 19, Its lesser curvature. 20, Its greater curvature. 21, The cardiac orifice. 22, The pyloric orifice. 23, The upper portion of the duodenum. 24, 25, The remainder of the duodenum. 26, Its valvulæ conniventes. 27, 29, The liver. 28, The gall bladder. 30, The hepatic duct. 31, The ductus communis choledochus. 32, Its opening into the duodenum. 33, The pancreas. 34, Its opening into the duodenum. 35, The upper part of the jejunum. 36, 36, 36, The ilium. 37, Some of its valvulæ conniventes. 38, The lower extremity of the ilium. 39, The ilio-colic valve. 41, The cæcum or caput coli. 42, The vermiform appendage. 43, 44, The ascending colon. 45, The transverse colon. 46, 47, 47, The descending colon. 48, The sigmoid flexure of the colon. 49, The upper portion of the rectum. 50, Its extremity. 51, A portion of the levator ani muscle. 52, The anus. 53, The spleen.

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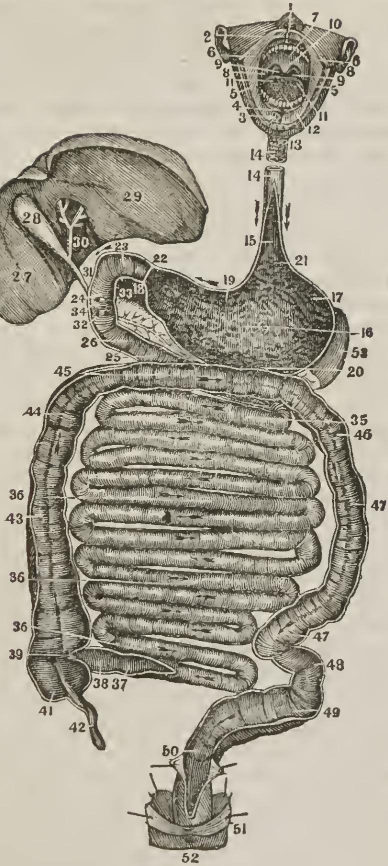
In the duodenum? In the large intestine? Give a law of the animal economy. What is the natural stimulus of the salivary glands? Of the stomach? Of the duodenum? Of the lacteal vessels? What effect has defective mastication or insalivation on the digestive process?

Fig. 104.



NOTE. — Let the student, from this engraving, review the anatomy and physiology of the digestive organs, that he may see where the different operations in digestion are performed, and by what agents they are produced. It will be profitable for the pupil to repeat this review until he shall become familiar, not only with the location and structure of the digestive organs, but with the laws and principles upon which health measurably depends.

The perfection of the digestive process, as well as the health of the general system, requires the observance of certain conditions. These will be considered under four heads. 1st. The quantity of food that should be taken. 2d. Its character. 3d. The manner in which it should be taken. 4th. The condition of the system at the time when taken.

1st. The quantity of food necessary for the system, is regulated by two circumstances; — *the rapidity of growth, and the amount of waste matter removed from the system in a given time.* The lad that exercises, and grows fast, not only needs food to promote the growth of the bones and muscles, but material to repair the waste of the system. Hence, we notice in the healthy, growing child, the frequent call for food, the keen appetite, and vigorous digestion. When the system is matured, there is less demand for food, as only a quantity sufficient to supply the loss attendant on the action of the skin, liver and other organs, is required.

In every department of nature, waste, or loss of substance, follows action. The great toe of the bronze statue of St. Peter, at Rome, has been reduced in size one half, by the kissing of the Romanist devotees; thus, kissing is attended with waste. The lad, or man, who is active, requires more nourishment than one of indolent habits; as the waste of one's system exceeds that of the other. The individual who has been accustomed to active employment, as agriculture, on leaving it, to pursue an employment of an opposite character, — as the learning of a sedentary trade, attending school, or engaging as a clerk, — requires less nutriment, as the waste of the system is diminished in nearly the same proportion as the exercise is lessened. If the same amount of food be taken after the diminution of the exercise, as before, a diseased condition of the system will be produced. *Students should guard against this evil the first few weeks of attending school; so should girls, who leave active household duties, for sedentary labor in the shop of the dress-maker.* If the digestive organs have been previously impaired, and continue in a debilitated state, the observance of this suggestion is of very great importance.

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How is the quantity of food taken regulated? Why does the lad require more food than the man of mature years? In every department of nature what is attendant on action? Does the man of sedentary habits require as much food as an active agriculturist? Why not? What caution is given to students?

2d. The quality of the food should be adapted to the distensible character of the stomach and intestines. The former will be full, if it contain only a gill; it may be so distended as to contain a quart. The same is true of the intestines. Consequently, if the food contain the quantity of nutriment which the system requires, in small bulk, the stomach and intestines will need the stimulation of distension and friction, which is consequent upon the introduction and transit of the innutritious material into and through the alimentary tract.

If the food be deficient in innutritious matter, the tendency is to produce an inactive and diseased condition of the digestive organs. Consequently, the nutrient food should have blended with it innutritious material. Unbolted wheat bread is more healthy than flour cakes; ripe fruits and vegetables than rich jellies.

The observance of this condition is of more importance to students, sedentary mechanics, and those individuals whose digestive apparatus has been enfeebled, than to those of active habits and firm health. This point has been and may be illustrated by experiments upon the lower order of animals. Feed a dog with pure sugar, or olive oil, articles that contain no innutritious matter, for several weeks, and the evil effects of concentrated nutriment will be manifested. At first, the dog will take his food with avidity, and seem to thrive upon it; soon his desire for food will diminish, his body emaciate, his eye become ulcerated, and in a few weeks he will die; but mix bran or saw-dust with the sugar or oil, and the health and vigor of the animal will be maintained for months. Similar phenomena will be manifested, if grain only be given to a horse, without hay, straw, or material of like character.

The circumstance that different articles of food contain different proportions of waste, may be made practically subservient in the following way. If, at any particular season of the year, there is a tendency to a diarrhœa, an article that contains a small proportion of waste should be selected for food; but if there is a tendency to an inactive or costive condition of the intestinal canal, such articles of food should be used as contain the greatest proportion of waste, as such articles are most stimulating to the digestive organs, and consequently most laxative.

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What is said of the distensible character of the stomach and intestines? Why should there be a combination of nutritious and innutritious matter in our diet? Give an experiment of feeding animals on nutrient material.

## A TABLE

Showing the mean time required for the digestion of different articles of diet.

| Articles of Diet. | Mode of Preparation. | Time required for Digestion H. M. |
|---|---|---|
| Rice, | Boiled, | 1 0 |
| Pigs' feet, soused, | Boiled, | 1 0 |
| Tripe, soused, | Boiled, | 1 0 |
| Eggs, whipped, | Raw, | 1 30 |
| Trout and Salmon, fresh, | Boiled, | 1 30 |
| Soup, barley, | Boiled, | 1 30 |
| Apples, sweet and mellow, | Raw, | 1 30 |
| Venison steak, | Broiled, | 1 35 |
| Brains, | Boiled, | 1 45 |
| Sago, | Boiled, | 1 45 |
| Tapioca, | Boiled, | 2 0 |
| Barley, | Boiled, | 2 0 |
| Milk, | Boiled, | 2 0 |
| Beefs' liver, fresh, | Broiled, | 2 0 |
| Eggs, fresh, | Raw, | 2 0 |
| Codfish, cured, dry, | Boiled, | 2 0 |
| Eggs, fresh, | Roasted, | 2 15 |
| Apples, sour and mellow, | Raw, | 2 0 |
| Cabbage, with vinegar, | Raw, | 2 0 |
| Turkey, wild, | Roasted, | 2 18 |
| " domestic, | Boiled, | 2 25 |
| Milk, | Raw, | 2 15 |
| Gelatin, | Boiled, | 2 30 |
| Turkey and Goose, domestic, | Roasted, | 2 30 |
| Pig, sucking, | Roasted, | 2 30 |
| Lamb, fresh, | Broiled, | 2 30 |
| Hash, meat and vegetables, | Warmed, | 2 30 |
| Beans, pod, | Boiled, | 2 30 |
| Cakes, sponge, | Baked, | 2 30 |
| Parsnips, | Boiled, | 2 30 |
| Potatoes, Irish, | Roasted, | 2 30 |
| " " | Baked, | 2 30 |
| Cabbage, head, | Raw, | 2 30 |
| Spinal marrow, | Boiled, | 2 40 |
| Chicken, full grown, | Fricassee, | 2 45 |
| Custard, | Baked, | 2 45 |
| Beef, with salt only, | Boiled, | 2 45 |
| Apples, sour and hard, | Raw, | 2 50 |
| Oysters, fresh, | Raw, | 2 55 |
| Eggs, fresh, | Soft boiled, | 3 0 |
| Bass, striped, fresh, | Broiled, | 3 0 |
| Beef, fresh, rare and lean, | Roasted, | 3 0 |
| Pork, recently salted, | Raw, | 3 0 |
| " " " | Stewed, | 3 0 |

| Articles of Diet. | Mode of Preparation. | Time required for Digestion. |
|---|---|---|
| Beef and mutton steak, | Broiled, | 3 0 |
| Mutton, fresh, | Boiled, | 3 0 |
| Soups, bean and chicken, | Boiled, | 3 0 |
| Aponeurosis, | Boiled, | 3 0 |
| Cake, corn, | Baked, | 3 0 |
| Dumpling, apple, | Boiled, | 3 0 |
| Oysters, fresh, | Roasted, | 3 15 |
| Pork, steak, | Broiled, | 3 15 |
| " recently salted, | Broiled, | 3 15 |
| Mutton, fresh, | Roasted, | 3 15 |
| Bread, corn, | Baked, | 3 15 |
| Carrot, orange, | Boiled, | 3 15 |
| Sausage, fresh, | Broiled, | 3 20 |
| Flounder, fresh, | Fried, | 3 30 |
| Catfish, fresh, | Fried, | 3 30 |
| Oysters, fresh, | Stewed, | 3 30 |
| Beef, fresh, dry, | Roasted, | 3 30 |
| " with mustard, &c., | Boiled, | 3 30 |
| Butter, | Melted, | 3 30 |
| Cheese, old and strong, | Raw, | 3 30 |
| Soups, mutton and oyster, | Boiled, | 3 30 |
| Bread, wheat, fresh, | Baked, | 3 30 |
| Turnips, flat, | Boiled, | 3 30 |
| Potatoes, Irish, | Boiled, | 3 0 |
| Eggs, fresh, | Hard boiled, | 3 0 |
| " " | Fried, | 3 0 |
| Corn, Beets and Beans, green, | Boiled, | 3 45 |
| Salmon, salted, | Boiled, | 4 0 |
| Beef, fresh and lean, | Fried, | 4 0 |
| Veal, fresh, | Broiled, | 4 0 |
| Fowls, domestic, | Boiled, | 4 0 |
| " " | Roasted, | 4 0 |
| Ducks, | Roasted, | 4 0 |
| Soup, (beef, vegetables and bread,) | Boiled, | 4 0 |
| Heart, animal, | Fried, | 4 0 |
| Beef, old, hard, and salted, | Boiled, | 4 15 |
| Pork, recently salted, | Fried, | 4 15 |
| Soup, marrow bones, | Boiled, | 4 15 |
| Cartilage, | Boiled, | 4 15 |
| Pork, recently salted, | Boiled, | 4 15 |
| Veal, fresh, | Fried, | 4 30 |
| Ducks, wild, | Roasted, | 4 30 |
| Suet, mutton, | Boiled, | 4 30 |
| Cabbage, with vinegar, | Boiled, | 4 30 |
| Suet, beef, fresh, | Boiled, | 5 3 |
| Pork, fat and lean, | Roasted, | 5 15 |
| Tendon, | Boiled, | 5 30 |

The preceding table exhibits the general results of experiments made on Alexis St. Martin, by Dr. Beaumont, when he endeavored to ascertain the time required for the digestion of different articles of food. The stomach of St. Martin was torn open by the bursting of a gun. When he recovered from the effects of the accident, under the surgical care of Dr. Beaumont, the stomach became adherent to the side, with an external aperture. Through this opening, the appearance of the coats of the stomach, and food at different stages of digestion, were examined.

In view of the foregoing table, the question may be suggested, is that article of food most wholesome which is most easily and speedily digested? To this it may be replied that the stomach is subject to the same law as the muscles and other organs; exercise, within certain limits, strengthens it. If, therefore, we always eat those articles most easily digested, the digestive powers will be weakened; if overworked, they will be exhausted. Hence, the quantity of food in this respect should be adapted to the maintenance of the digestive powers, and to their gradual invigoration when debilitated.

3d. How should food be taken? 1st. It should be taken at stated periods. The interval between meals should be regulated by the character of the food, the age, health, exercise, and habits of the individual. The digestive process is more energetic and rapid in the young, active and vigorous, than in the aged, indolent and feeble; consequently, food should be taken more frequently by the former than by the latter class. In some young and vigorous persons, food may be digested in one hour, in other persons it may require four hours or more. In most instances from two to four hours will be required to digest ordinary meals. In all instances, the stomach will require from one to three hours to recruit its exhausted powers after the labor of digesting a meal, before it will again enter upon the vigorous performance of its functions. If food be taken before the stomach has regained its tone and energy by repose, the secretion of the gastric juice, and the contraction of the muscular fibres, will be imperfect. Again, if food be taken before the digestion of the preceding

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How should food be taken? How often? How long should the stomach rest after the food has been digested? What will be the effect if food be taken before the stomach has regained its tone and vigor? Should food be taken into the stomach before a preceding mea has been digested?

meal has been completed, the effects will be still worse, because the food partially digested becomes mixed with that last taken. The interval between each meal should be long enough for the whole quantity to be digested, and the time of repose should be sufficient to recruit the exhausted organs. The more feeble the person, and the more debilitated the stomach, the more important to observe the above directions. In the feeding and nursing of infants, as well as in supplying food to older children, it should always be regarded. The person who has been confined by an exhausting sickness should most scrupulously regard this rule, if he would recruit his strength and flesh with rapidity. As the rapidity of the digestive process is less in students and persons who are engaged in sedentary employments, than in stirring agriculturists, the former classes are more liable to violate this condition than the latter, while its observance is of greater importance to the sedentary artisan than to the lively lad and active farmer. Hence, the attention of the sedentary and feeble is particularly invited to the suggestions of this paragraph.

2d. Food should be taken not only at stated periods, *but in a proper manner*. All solid aliment should be reduced to a state of comparative fineness before it is swallowed; the gastric fluid of the stomach will then blend with it more readily, and act more vigorously in reducing it to chyme. The practice of swallowing solid food, slightly masticated, or bolting it down, tends to derange the digestive process, and impair the nutrition of the system.

Mastication should be moderate, not rapid, for the salivary glands are excited to action in chewing, and some time must elapse before they can secrete saliva in sufficient quantities to moisten the food. If the aliment is not supplied with saliva, digestion is retarded. Hence, rapid or fast eating has a tendency to induce disease.

3d. As the salivary glands supply fluid to moisten the dry food, the use of tea, coffee, water, or any other fluid, is not demanded by nature's laws while taking a meal. There are two objections to washing down the food with considerable

How long should be the interval between each meal? Should the manner of taking food as well as regularity be noticed? What is said of the practice of "bolting down" the food? What is said of rapid eating? What objections to the use of tea and coffee?

quantities of common drinks. One is, the aliment is moistened, not with the saliva, but with the drink. This tends to induce disease, not only in the salivary organs, by leaving them in a state of comparative inactivity, but in the stomach, by the deficiency of the salivary stimulus. The other is, large quantities of fluids, used as drinks, give undue distension to the stomach, and lessen the energy of the gastric juice by its dilution. The horse is never known to leave his provender, nor the ox his blade of grass, to wash it down; but many persons, from habit rather than thirst, drink largely during meals. While the washing down of food is productive of evil, a moderate amount of drink after eating may aid in the digestion of food, but it is not absolutely necessary.

4th. When food or drink is taken hot, the vessels of the mucous membrane of the gums, mouth and stomach are unduly stimulated for a short time, and this is followed by reaction, attended with a loss of tone and debility of the mucous membrane. This practice is a fruitful cause of spongy gums, decayed teeth, sore mouth, and indigestion.

Again, if a considerable quantity of very cold food or liquid be taken immediately into the stomach, the health will be endangered, and the tone of the system will be impaired, from the sudden abstraction of heat from the coats of the stomach, and surrounding organs, to impart warmth to the cold food or drink. Consequently, food and drink should be taken neither very hot nor very cold, but moderately heated; this is best adapted to the natural condition of the digestive apparatus.

What should be the condition of the general system at the time when food is taken?

1st. Food should not be taken immediately after severe manual or mental exertions. For all organs in action, require and receive more blood and nervous fluid, than when at rest. This is the case with the brain and limbs when exercised; and the same is true of the stomach and intestines, during the digestion of food. The increased amount of fluid, both sanguineous and nervous, supplied to any organ during *extra* functional action, is abstracted from other parts of the system. This enfeebles and prostrates the parts that supply the blood

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When may a moderate amount of drink aid digestion? What is the effect when liquids are drank hot? What is the effect when liquids are taken iced or cold? What temperature of liquids is adapted to the system? Should food be taken immediately after manual or mental exertion?

and nervous fluid to the active organ. Again, when any organ has been in vigorous action for a few hours, some time will elapse before the increased action of the arteries and nerves abates, and a due supply of fluids is transmitted to other organs, or an equilibrium of action in the system is re-established.

2d. If the muscles are called into vigorous action, by labor, walking, or running, there will be a determination of blood and nervous influence to them. The digestive organs will be in a state of comparative inactivity, and consequently unfit to digest food. For this reason, severe exercise should not be taken immediately after eating a full meal. Nor should the respiratory or vocal organs be called into active exercise in declaiming or singing; nor the brain be employed in continued thought, for an hour or two, *before* or *after* taking a full meal. But moderate exercise of the muscular system, conjoined with agreeable conversation and a hearty laugh, facilitates digestion.

To illustrate this principle,—feed two dogs upon similar articles of food; let one lie down quiet, and the other be sent in pursuit of game. At the expiration of one hour, have them killed. The stomach of the one that had remained quiet, will be nearly or quite empty, while the food in the other will be found nearly unaltered. In the one, the energies of the system have been concentrated on the stomach; in the other, they have been exhausted on the organs of motion. So it is with man; if his mind or muscles act intensely, soon after eating, the stomach will not be sufficiently stimulated to change the food in a suitable period. If food be retained in the stomach an unusual length of time, irritation will be produced.

3d. The mind exerts an influence upon the digestive process. This is clearly exhibited, when an individual receives the intelligence of the loss of a friend or of property. He may at the time be sitting before a plentiful board, with a keen appetite; but the unexpected news destroys it, because

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Give the reasons why food should not be taken after exertion. Why should not the respiratory or vocal organs be called into active exercise immediately before or after eating? What facilitates digestion? What example is given to illustrate the effects of calling two leading organs into action at the same time? Has the mind any effect on digestion? Relate an instance from common observation.

the excited brain withholds its stimulus. Indigestion arising from a prostration of the nervous system should be treated with great care. The food should be simple, nutritious, moderate in quantity, and taken at regular periods. Large quantities of stimulating food, frequently taken, serve to increase the nervous prostration. Those afflicted should exercise in the open air, and engage in social conversation, that the brain may be excited to a natural or healthy action, in order that it may impart to the digestive organs the necessary stimuli.

4th. It is no unusual occurrence, for those persons who have eaten heartily immediately before retiring for sleep, to have unpleasant dreams, or to be aroused from their unquiet slumber by colic pains. In such instances, the brain becomes dormant, and does not impart to the digestive organs the requisite amount of nervous influence. The nervous stimulus being deficient, the unchanged food remains in the stomach, causing irritation of this organ.

The practical rule should be, *to abstain from eating at least three hours before retiring for sleep.*

5th. When the digestive organs and general system are debilitated and rendered irritable by deprivation of food for a considerable period, as in the instance of a shipwrecked and famished mariner, or a patient recovering from disease, but a small quantity of nourishment should be given at a time, and this of a nature to be easily digested. The reason for this is, that a stomach weakened by want of food is as unfitted for a long period of action in digesting food, as are the muscles, under like circumstances, for walking. Consequently, knowledge and prudence should direct the administration of food under the above-mentioned circumstances. The popular adage, that "food never does harm when there is a desire for it," is untrue, and if practically adopted, may be injurious and destructive to life.

6th. The condition of the skin exercises an important influence on the digestive apparatus. Let free perspiration be checked, either from uncleanliness, or from chills, and it will diminish the functional action of the stomach and its associ-

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What is said of indigestion arising from a prostration of the nervous system? What effect has the eating of food immediately before retiring? What practical rule is given? What is said of the adage, that "food never does harm when there is a desire for it"? Is there sympathy between the skin and the digestive organs?

ated organs. This is one of the fruitful causes of the "liver and stomach complaints," among the half-clothed and filthy population of the crowded cities and villages of our country.

Fig. 105.

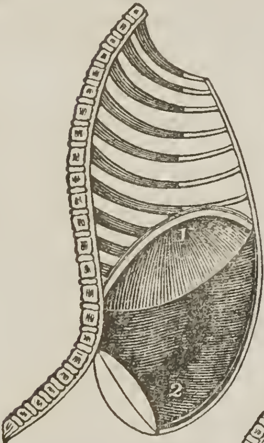


Fig. 106.


Fig. 105. Represents the antero posterior section of the chest when the lungs are inflated. 1, The diaphragm, 2, The muscular walls of the abdomen.
Fig. 106. Represents the antero posterior section of the thorax, or chest, when the lungs are contracted. 1, 1, The diaphragm. 2, 2, The muscular walls of the abdomen.
These engravings show the diaphragm to be more convex, and the walls of the abdomen more flattened, when the lungs are contracted, than when they are inflated.

7th. Restricting the movements of the ribs and diaphragm impairs digestion, not only by preventing the oxydation of the blood in the lungs, but by impeding the action of the abdominal organs, induced by the elevation and depression of the diaphragm. At each full inspiration, the ribs are elevated, and the central portion of the diaphragm is depressed, from one to two inches. This depression is accompanied by a relaxation of the anterior abdominal muscles. At each act of expiration, the relaxed abdominal muscles contract, the ribs are depressed, the diaphragm relaxes, and its central parts ascend.

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What is one fruitful cause of liver complaints among the poorly clothed inhabitants of crowded citics and villages? Why does restricting the movements of the ribs and diaphragm impair digestion? Does inspiration effect the abdominal organs? How?

These movements of the midriff cause the elevation and depression of the stomach, liver, and other abdominal organs. It is noted of individuals who restrain the free movements of the abdominal muscles by tight dresses, that the tone and vigor of the digestive organs are diminished. The restricted waist will not admit of a full and deep inspiration; and so essential is this to health, that abuse in this respect soon enfeebles and destroys the functions of the system.

The effect of impure blood, in diminishing the desire for food and enfeebling the digestive organs, is well illustrated by the following incident. During the sitting of the committee appointed by the British Parliament, to inquire into the effects that manufacturing employment had upon the physical system, among several persons examined, a witness stated that, some years before, he had ventilated his mill on a well-devised plan. The apparatus was removed at a subsequent period. On being asked the reason for removing it, he replied, he noticed after the mill was ventilated, that his men consumed a greater quantity of food; and rather than incur an extra expense for beef, he caused the ventilating apparatus to be taken out. From this testimony, we learn why those persons who sleep in small, badly-ventilated rooms, have little or no appetite in the morning, and why the mouth and throat are so dry and disagreeable.

8th. The position of a person, when standing or sitting, exerts an influence upon the digestive organs. If a person lean, or stoop forward, the distance between the pelvic bones and the diaphragm is diminished. This prevents the depression of the diaphragm, while the stomach, liver, pancreas, and other abdominal organs, suffer compression, which induces many severe diseases of these organs. As healthy and well-developed muscles keep the spinal column in an erect position, which conduces to the health of the organs of digestion, the child should be taught to avoid all positions *but the erect*, while studying or walking. This position, combined with unrestricted waists, will do much to remove the now prevalent disease, dyspepsia.

9th. In warm weather, the vessels of the skin are more active than in cold. This is attended by a comparatively en-

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What effect has impure blood upon the digestive organs? Give the statement of an English manufacturer. How do the attitudes affect digestion? What is the usual condition of the digestive organs in very warm weather?

feebled state of the stomach, and an increased irritability of the intestinal tract. This condition of the system points to the necessity of diminishing the quantity of aliment taken, and also of its being less stimulating in character, in warm, than in cold weather. By observing this suggestion, and by clothing and bathing the system properly, diseases of the intestines, or "season complaints," would be, to a considerable extent, prevented.

Whatever kind of aliment be taken, it is separated into nutriment and residuum; the former of which is conveyed, through the medium of the circulation, to all organs of the system, and the latter, if not expelled, accumulates, causing headache and dizziness, with a general uneasiness, and, if allowed to continue, it lays the foundation of a long period of suffering and disease. For the preservation of health, it is necessary that there should be a daily evacuation of the residual matter. We would add, for the benefit of those affected with hemorrhoids, or piles, that the best time for evacuating the intestinal canal, would be immediately before retiring for sleep. To recapitulate: digestion is most perfect, when the action of the cutaneous vessels is energetic; the brain and vocal organs moderately stimulated by animated conversation; the blood well purified; the muscular system duly exercised; the food taken at regular periods, and properly masticated.

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What caution relative to food in warm weather? When is digestion most perfect?

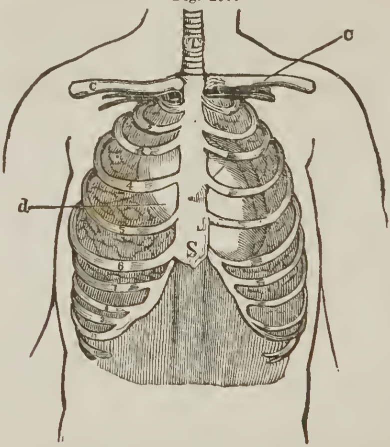
# CHAPTER VII.

## ORGANS OF RESPIRATION.

The organs of respiration are the *lungs*, the *larynx*, and the *trachea*. The ribs, the diaphragm, and several muscles, are also subservient to the respiratory process.

The THORAX, sometimes called the *chest*, is bounded posteriorly, by the spinal column, posterior extremity of the ribs, and the intercostal muscles; laterally, by the ribs and intercostal muscles; anteriorly, by the sternum, anterior extremity of the ribs, and the cartilages which connect the ribs to the sternum; inferiorly, by the diaphragm, which separates this cavity from the abdomen. The natural form of the chest is a truncated cone. The correct form of the chest, and the position of the organs contained in it, are represented by the three following engravings.

Fig. 107.

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*Name the organs of respiration.* How is the thorax bounded? Its form? What does Fig. 107 exhibit?

Fig. 107. Represents the position of the heart and lungs, as they lie in the chest. The figures from 1 to 10, indicate the ribs, the two lower of which are not seen. In this engraving, the spaces between the ribs are not filled by the intercostal muscles. The lungs and heart are seen between the ribs. c, c, The clavicles. T, The trachea. S, The sternum *d*, The heart.

Fig. 108.

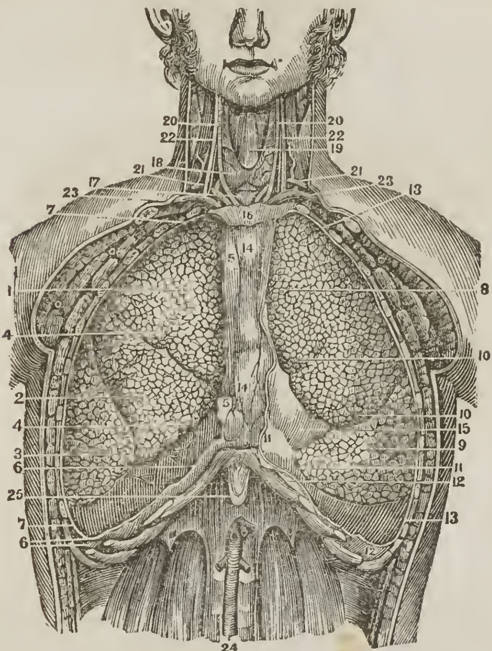


Fig. 108. An anterior view of the thoracic viscera, showing their relative position, by the removal of the anterior walls of the chest. 1, The superior lobe of the right lung. 2, Its middle lobe. 3, Its inferior lobe. 4, 4, Lobular fissures. 5, 5, The internal layer of the costal pleura, forming the right side of the anterior mediastinum. 6, 6, The portion of the pleura that lines the right side of the diaphragm. 7, 7, The pleura costalis of the right side. 8, Superior lobe of the left lung. 9. Its inferior lobe. 10, 10, Interlobular fissures. 11, 11, The portion of the pleura costalis which forms the left side of the anterior mediastinum. 12, The portion of the pleura which covers the right side of the diaphragm. 13, 13, The left pleura costalis. 14, 14, The middle space between the pleuræ, known as the anterior mediastinum. 15, The pericardium. 16, The fibrous partition over which the pleuræ are reflected. 17, The trachea. 18, The thyroid gland. 19, The anterior portion of the thyroid cartilage. 20, 20, The primitive carotid artery. 21, 21, The subclavian veins. 22, 22, The internal jugular veins. 23, 23, The brachio-cephalic veins. 24, The abdominal aorta. 25, The ensiform cartilage.

Around the pericardium, and in both the anterior and posterior mediastinum, there is deposited a considerable quantity of adipose or fatty matter; but under no circumstances is there any found in either the cavities of the pleura or pericardium. In both these cavities, there is always a small amount of fluids to lubricate the parts and lessen friction. Sometimes this is deposited in large quantities, forming the disease termed dropsy of the chest or heart.

Fig. 109.

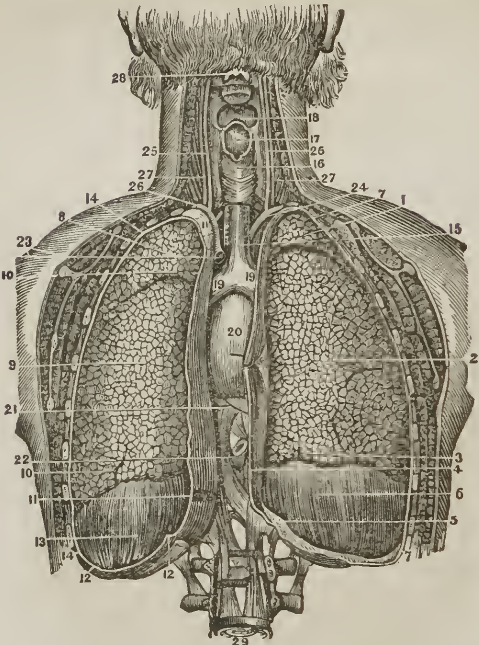


Fig. 109. A posterior view of the thoracic viscera, showing their relative position, by the removal of the posterior portion of the walls of the chest. 1, 2, The upper and lower lobes of the right lung. 3, Interlobular fissures. 4, The internal portion of the pleura costalis, forming one of the sides of the posterior mediastinum. 5, The twelfth rib and lesser diaphragm. 6 and 13, The diaphragm. 7, The right pleura costalis, adhering to the ribs. 8, 9, The two lobes of the left lung. 10, 10, Interlobular fissures. 11, The left pleura, forming the walls of the posterior mediastinum. 12, 12, Its reflections over the diaphragm on this side. 14, 14, The left pleura costalis on the walls of the chest. 15, The trachea. 16, The larynx. 17, The opening of the larynx and the epiglottis cartilage. 18, The root and top of the tongue. 19, 19, The right and left bronchi. 20, The heart, enclosed in the pericardium. 21, The upper portion of the diaphragm, on which it rests. 22, A section of the œsophagus. 23, A section of the aorta. 24, The arteria innominata. 25, 25, The primitive carotid arteries. 26, The subclavian arteries. 27, 27, The internal jugular veins. 28, The second cervical vertebra. 29, The fourth lumbar vertebra.

## ANATOMY OF THE LUNGS AND TRACHEA.

The LUNGS are conical organs, one on each side of the chest, embracing the heart, and separated from each other by

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*Describe the lungs.* Where situated?

a membranous partition, called the *mediastinum.* The color of the lungs is a pinkish gray, mottled, and variously marked with black. Each lung is divided into lobes, by a long and deep fissure, which extends from the posterior surface of the upper part of the organ, downward and forward, nearly to the anterior angle of the base. In the right lung, the upper lobe is subdivided by a second fissure. This lung is larger and shorter than the left. It has three lobes, while the left has only two.

Each lung is enclosed, and its structure maintained, by a serous membrane, named the *pleura,* which invests it as far as the root, and is thence reflected upon the parietes, or walls of the chest. That part of the membrane which is in relation with the lung, is called the *pleura pulmonalis;* and that part which is in contact with the parietes, the *pleura costalis.*

**Fig. 110.**

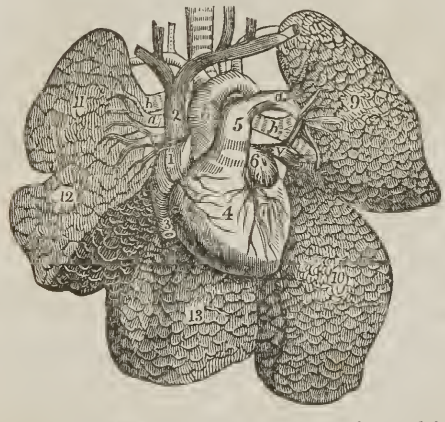


**Fig. 110.** Exhibits the heart and lungs removed from the chest, and the lungs freed from all other attachments. They are arranged so as to show the parts with greater accuracy. 1, The right auricle of the heart. 2, The superior vena cava. 3, The inferior vena cava. 4, The right ventricle. 5, The pulmonary artery issuing from it. *a, a,* The pulmonary artery (right and left) entering the lungs. *b, b,* Bronchi, or air-tubes, entering the lungs. *v, v,* Pulmonary veins issuing from the lungs. 6, The left auricle. 7, The left ventricle. 8, The aorta. 9, The upper lobe of the left lung. 10, Its lower lobe. 11, The upper lobe of the right lung. 12, The middle lobe. 13, The lower lobe.

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Their color? How is each lung divided? Are the number of lobes equal in each lung? What is the office of the pleura? What is that portion called which covers the lungs? That which is in contact with the ribs?

The two reflected pleuræ in the middle of the thorax, form a partition, which divides the chest into two cavities. This partition is called the *mediastinum*.

Fig. 111.

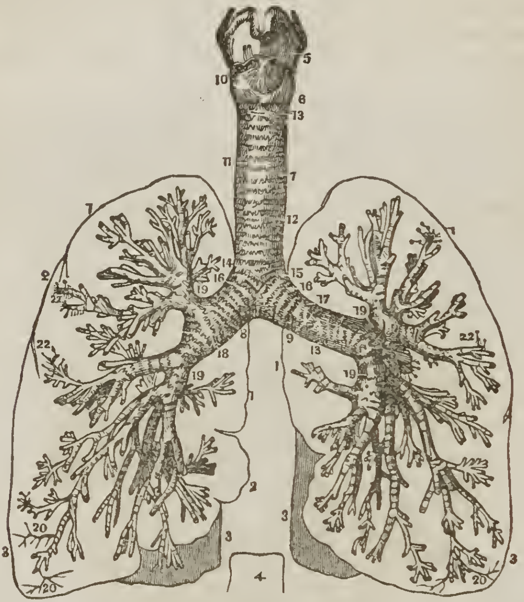

Fig. 111. Exhibits the larynx, trachea, and bronchi, deprived of their fibrous covering, and with an outline of the lungs. 1, 1, An outline of the upper lobe of the lungs. 2, 2, An outline of the middle lobe of the right lung. 3, 3, 3, 3, An outline of the inferior lobe of both lungs. 4, An outline of the ninth dorsal vertebra. 5, The thyroid cartilage. 6, The cricoid cartilage. 7, The trachea. 8, The right bronchus. 9, The left bronchus. 10, The crico-thyroid ligament. 11, 12, The rings of the trachea. 13, The first ring of the trachea. 14, The last ring of the trachea, which is corset-shaped. 15, 16, A complete bronchial cartilaginous ring. 17, One which is bifurcated. 18, Double bifurcated bronchial rings. 19, 19, 19, 19, Smaller bronchial rings. These divide into still smaller tubes, which terminate in small air sacs, as seen at 20, 20, 20, 20, 22, 22, 22.

The lungs are composed of the ramifications of the bronchial tubes, which terminate in the bronchial cells *(air cells)* of the divisions of the pulmonary artery and veins, bronchial arteries and veins, lymphatics, and nerves. All of these are

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How is the thorax divided into two cavities? What other name has the partition? Of what are the lungs composed?

held together by cellular tissue, which constitutes the *parenchyma.*

Each lung is retained in its place by its *root,* which is formed by the pulmonary artery, pulmcnary veins, and bronchial tubes, together with the bronchial vessels, and pulmonary plexus of nerves.

The LARYNX, from the Greek *larugx,* a whistle, is situated at the anterior part of the neck, between the trachea and the base of the tongue.

The TRACHEA, sometimes called the *wind-pipe,* extends from the larynx, of which it is a continuation, to the third dorsal vertebra, where it divides into two parts, called *bronchi.* It lies immediately anterior to the spinal column, from which it is separated by the œsophagus.

The two BRONCHI proceed from the bifurcation of the trachea, to their corresponding lungs. Upon entering the lungs, they divide into two branches, and each branch divides and subdivides, and ultimately terminates in small sacs, of various sizes, from the twentieth to the hundredth of an inch in diameter. So numerous are these bronchial or air cells, that the aggregate extent of their lining membrane in man has been computed to exceed a surface of 20,000 square inches.

Fig. 112.


Fig. 112. 1, A bronchial tube. 2, 2, 2, Air vesicles. Both the tube and vesicles are much magnified. 3, A bronchial tube and vesicles laid open.

The small bronchial tubes and cells compose the largest portions of the lungs. These, when once inflated, contain air, under all circumstances, which renders their specific gravity

What is the parenchyma of the lungs? How is the root of the lung formed? Describe the larynx. Describe the trachea. Describe the bronchi. In what do the bronchial tubes terminate? The size of these cells? The extent of their lining membrane? Do the lungs when once inflated always contain some air in the cells?

much less than water; hence the vulgar term, *lights*, for these organs. The trachea, brcnchi, and air-cells are lined with mucous membrane.

The lungs, like other portions of the system, are supplied with *nutrient* arteries, veins, absorbents, and nervous filaments, from the ganglionic system of nerves, and from the pneumogastric nerve. The muscles that elevate the ribs and the diaphragm receive nervous fibres from a separate system, which is called the *respiratory*.

## PHYSIOLOGY OF RESPIRATION.

Respiration, or breathing, consists in inhaling air into the lungs and expelling it from them. At each act of inspiration, certain muscles, called *respiratory*, elevate the ribs, while the central portion of the diaphragm is depressed by the contraction of its muscular portion, and the increase of the diameter of the chest. The abdominal muscles relax, and the abdomen becomes more protruded, simultaneously with the elevation of the ribs and depression of the diaphragm. The movement of the ribs and diaphragm enlarges the thoracic cavity, and causes a comparative vacuum in the lungs; the equilibrium is restored by the air which is forced by atmospheric pressure into the bronchial tubes and cells.

Fig. 113.

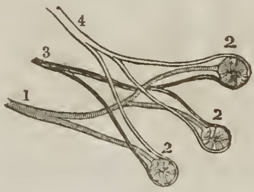


Fig. 113. 1, Represents a bronchial tube, dividing into three branches, which terminate in three air-vesicles, (2, 2, 2.) 3, A branch of the pulmonary artery, dividing into three branches, that are seen ramifying upon the air vesicles (2.) 4, A pulmonary vein, formed by the union of smaller veins, that connect with the capillary arteries upon the vesicles 2, 2, 2.

In expiration, the ribs are depressed by the contraction of the abdominal muscles, the diaphragm relaxes, and its central

With what are the lungs supplied? *Define respiration.* What change in the position of the organs of the thorax when we inspire air? Describe the change of the thoracic organs during expiration.

portion is forced upward. This contracts the cavity of the chest, and diminishes the volume of the lungs, causing the expulsion of the air contained in the air-cells.

From the right side of the heart, the impure venous blood is conveyed into the lungs, through the *pulmonary artery.* This artery divides and subdivides, until the vessels become so small as to resemble hairs in size; hence, they are called *capillary*, or hair-like vessels. These small vessels ramify over the thin walls of the air-cells. Here the blood, which is impelled from the heart into these minute tubes, is separated from the air, by the thin walls of the air-cells, and coats of the capillary vessels.

Fig. 114.

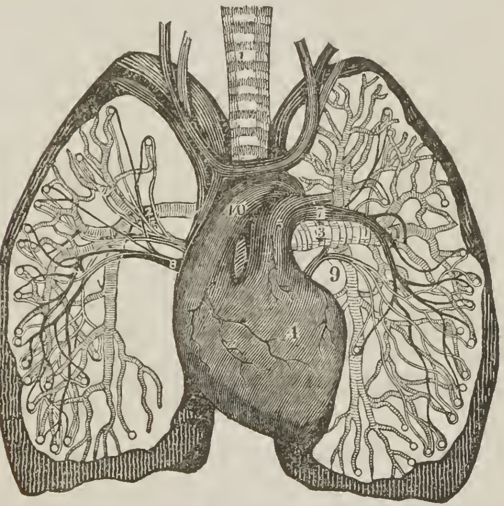


Fig. 114. 1, The trachea. 2, The right bronchus. 3, The left bronchus. 4, The heart. 5, The pulmonary artery. 6, Its branch to the right lung. 7, Its branch to the left lung. 8, The right pulmonary vein. 9, The left pulmonary vein. 10, The aorta. The bronchial tubes terminate in vesicles.

Air from the trachea, 1, enters the bronchi, 2 and 3. Through these branches, it passes to the vesicles at their extremities. The minute division of the right and left pulmonary arteries pass over the vesicles. Here the dark blood sent from the right side of the heart is purified; it is then returned, through the small vessels that unite to form the pulmonary veins, 8 and 9, to the left side of the heart.

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What is the name of the artery that conveys the venous blood to the lungs? What is said of the subdivisions of this artery?

At this point, the air in the cells, acting upon the blood in the capillary vessels, changes the dark venous blood to a bright red, or vermilion hue. It is then returned, through another set of vessels, named *pulmonary veins*,* to the left side of the heart.

As the inhaled air is the effective agent in converting venous blood into arterial, its chemical analysis is given. On examination, it is found to consist of two gases, *oxygen* and *nitrogen*, or *azote*. They are mixed, in the atmospheric air, in the proportion of one fifth of oxygen, and four fifths of nitrogen. A small proportion of carbonic acid, and also the effluvia of flowers, are combined with these.

All physiologists agree upon the three following points. 1st. The blood contains carbon. 2d. The carbon is changed into carbonic acid gas, and, in this state, it is removed from the system through the lungs and skin. 3d. The separation of carbon from the blood, — and, it may be, the union of oxygen with other elements of this fluid,—changes it from a dark color to a vermilion red.

Two theories have been adopted to explain the formation of the carbonic acid gas eliminated from the system. 1st. The carbon is converted into carbonic acid gas, *in the lungs*, by a union of oxygen with it from the inspired air. 2d. In the lungs, the oxygen separates from the nitrogen, and unites with the blood, and in the general circulation, a chemical union of the carbon and oxygen is effected, by which the carbonic acid gas eliminated from the system through the lungs and skin is formed. The latter view is most generally adopted by physiologists. The following experiment will show that water will pass through a membrane more readily than alcohol.

Put a mixture of water and alcohol into a phial, and leave

* All the tubes or canals that convey blood *from* the heart, are named *arteries*, while those that convey blood *to* the heart, are called *veins*. The names artery, and vein, have no reference to the color of the blood which flows through them.

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At what point does the venous blood assume a vermilion color? Through what vessels is the arterial blood returned to the heart? What is the effective agent in converting venous into arterial blood? Do all physiologists agree that the blood contains carbon? Upon what other points in this connection do they agree? Give the theories in relation to the elimination of carbon from the system. Which view is generally adopted? What experiment is given?

it uncorked. Both the water and alcohol have a greater affinity for air than for each other. Alcohol has the greatest affinity for the air, and will be diffused through it more readily than the water, when there is no intervening obstacle. But tie a piece of bladder over the mouth of the phial, and let it stand a few days; the water will leave the alcohol, and pass through the membrane. By the aid of this experiment, we shall endeavor to explain the interchange of fluids in the lungs.

The walls of the air-vesicles, and coats of the blood-vessels, are similar in their mechanical arrangement, to the membranous bladder in the above-described experiment. The oxygen of the air has greater affinity for blood than for nitrogen, and permeates the membranes that intervene between the air and blood, more readily than the nitrogen. The carbonic acid gas has a greater affinity for air than for blood. It will also pass through the walls of the blood vessels and air cells more readily than the blood.

The venous blood contains carbonic acid gas, which gives it a blackish red color. When this impure blood passes over the air-vesicles, a portion of the oxygen in the air-cells permeates their walls, and the coats of the minute blood-vessels, and unites with the venous blood. At the same time, carbonic acid gas leaves the venous blood, passes through the coats of the blood vessels and air-cells, and mixes with air. This interchange of products alters the color and character of the blood.

## PRACTICAL SUGGESTIONS.

The quantity of pure air supplied to the lungs, should be proportioned to the amount of carbonic acid gas to be eliminated from the system. This is modified by the exercise and quantity of food that are taken. The active man demands more air than a sedentary individual, and the gormandizer, than a person of abstemious habits.

The quantity of carbonic acid gas actually eliminated from the system, depends on three conditions. 1st. The volume

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In what manner is the blood oxydated or changed in the lungs? To what should the quantity of air supplied to the lungs be proportioned? Why does the man of active habits require more air than one of sedentary habits? The gormandizer than one of abstemious habits? Upon what conditions does the actual elimination of carbonic acid gas from the system depend?

of the lungs. 2d. The movements of the ribs and diaphragm. 3d. The purity of the air.

1st. As the quantity of air inhaled is modified by the capacity of the respiratory organs, *the necessity of ample volume of lungs* will be elucidated by the following experiment. Suppose a gill of alcohol, mixed with a gill of water, be put into a vessel having a square foot of surface, and over the vessel a membrane be tied, and that the water will evaporate in twenty-four hours. If the surface had been only six inches square, only one fourth of the water would have evaporated through the membrane in the given time. If the surface had been extended to two square feet, the water would have evaporated in twelve hours. Apply this principle to the lungs; suppose there are two hundred cubic feet of carbonic acid gas to be carried out of the system every twenty-four hours. This gas, in that time, will pass through a membrane of vesicular surface of two thousand square feet. If the lungs were diminished in size, so that there would be only one thousand square feet of vesicular membrane, this amount of gas could not, and would not, be eliminated from the system. Under such circumstances, the blood would not be purified. Again: suppose the two thousand square feet of membrane would transmit two hundred cubic feet of oxygen into the system every twenty-four hours. If it should be diminished one half, this amount of oxygen would not pass into the blood. From the above illustrations, we may learn the importance of well-developed chests, and voluminous lungs, for, by increasing the size of the lungs, the oxygen is more abundantly supplied to the blood, which is thus more perfectly deprived of its carbonic acid gas.

The chest of a child or adult, when properly formed, may be contracted by compression, and thus the size of the lungs be reduced. This may be effected by the *moderate* and *constant* pressure of the apparel, over the yielding cartilages and ribs, particularly in infancy. For want of physiological knowledge of the pliant character of the cartilages and ribs in infants, too many mothers, unintentionally, contract their chests, and thus sow the seeds of disease by the close dressing of their offspring.

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Give the experiment that elucidates the necessity of ample volume of the lungs. Can the chest of an adult be contracted? How effected? Which is most easily contracted, the chest of an adult or that of a child? Why? What is the consequence of diminishing the size of the chest?

If this slight but steady pressure be continued, from day to day and from week to week, the ribs will continue to yield more and more, and, after the expiration of a few months, the chest will become diminished in size. This will be effected without any suffering of a marked character; but the general health and strength will be impaired. It is not the violent and ephemeral pressure, but the moderate and protracted, that produces the genteel contracted chests.

Fig. 115. Fig. 116.

Fig. 115. Is a correct outline of the Venus de Medicis, the *beau ideal* of female symmetry.

Fig. 116. Is an outline of a well-corseted modern beauty. One has an artificial, insect waist, the other the natural waist of woman. One has sloping shoulders, while the shoulders of the other are comparatively elevated, square, and angular. The proportion of the corseted female below the waist is also a departure from the symmetry of nature.

The style of dress which at the present day is almost universal, is a prolific cause of this deformity. These baneful fashions are copied from the periodicals, so widely circulated, containing a "fashion plate" of the "latest fashions," from Paris. In every instance, the contracted, deformed, and, as it is called, neat, lady-like waist, is portrayed in all its fascinating loveliness. These periodicals are found on almost every

Is the contracted chest produced in a day? What is said in regard to the style of dress at the present time?

centre-table, and exercise an influence almost omnipotent. If the plates which corrupt the morals are excluded by civil legislation, with the same propriety ought not those to be suppressed that have a tendency so adverse to health?

The chest is not only most expanded at its lower part, but the portion of the lungs that occupies this space of the thoracic cavity contains the greater part of the air-cells. Hence, from the lower two-thirds of the lungs the greatest amount of carbonic acid gas is abstracted from the blood, and the greatest amount of oxygen gas is conveyed into the blood. For this reason, contracting the lower ribs is far more injurious to the health than diminishing the size of the upper part of the chest.

SKELETONS OF A WELL-FORMED FEMALE CHEST, AND A CONTRACTED ONE.

Fig. 117.

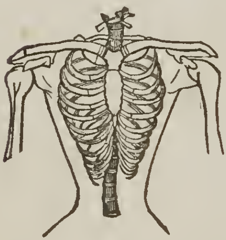

Fig. 118.

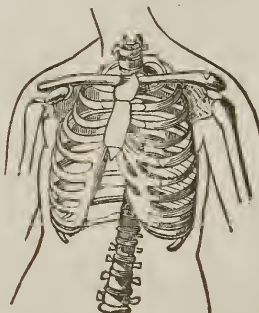

Fig. 117. An outline is here presented of a female, to show the condition of the bones as they appear after death, in every woman who has habitually worn stays. All the false ribs, from the lower end of the breast bone, are unnaturally cramped inwardly towards the spine, so that the liver, stomach, and other digestive organs in the immediate vicinity, are pressed into such small compass, that their functions are interrupted, and in fact all the vessels, bones, and organs, on which the individual is constantly depending for health, are more or less distorted and enfeebled. This figure may be regarded as the exact shape and figure of a short-lived female.

Fig. 118. May be contemplated as an equally true model of the frame of another, who, so far as life depends upon a well-formed body, would live to a good old age. Here is breadth, space for the lungs to act in, and the short ribs are thrown outwardly instead of being curved and twisted towards the spine, by which ample space is afforded for the free action of all those organs, which in the other frame were too small to sustain life.

The question is often asked, can the size of the chest and

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Where is the cavity of the chest most expanded? Where are the greater part of the air-cells situated?

the volume of the lungs be increased, when they have been injudiciously compressed, or have inherited this unnatural form. The answer is in the affirmative. The means for attaining this end are, a judicious exercise of the lungs, by walking in the open air, reading aloud, singing, sitting erect, and fully inflating the lungs at each act of inspiration. If the exercise be properly managed, and persevered in, it will expand the chest, and give tone and health to the important organs contained in it. But if the exercise be ill-timed or carried to excess, the beneficial results sought for will probably not be attained.

2d. As the quantity of air inhaled at each unimpeded inspiration in lungs of ample size, is from twenty to forty cubic inches, if the movement of the ribs and diaphragm be restricted, the blood will not be perfectly purified. In the experiment, (page 164,) suppose twenty cubic inches of air must pass over the membrane twenty times every minute, and that this is the amount required to remove the vapor which arises from the membrane ; if only half of this amount of air be supplied each minute, only one half as much water will be removed from the alcohol through the membrane in twenty-four hours ; consequently, the alcohol would be impure, from the water not being entirely removed.

Restrain the elevation of the ribs and depression of the diaphragm, so that the quantity of air conveyed into the lungs will be reduced to ten cubic inches, when twenty are needed, and the results will be as follows ; only one half of the carbonic acid will be eliminated from the system, and the blood will receive but one half as much oxygen as it requires. This fluid will then be imperfectly oxydated, and partially freed of its impurities. The impure blood will be returned to the left side of the heart, and the whole system will suffer from an infringement of organic laws.

As the position and movement of the ribs and diaphragm are not generally understood, and as this is attended with injurious effects in the application of clothing, attention is invited to figs. 118, 119, and 120. It will be seen that the ribs are attached to the bodies of the vertebræ, and that they

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What modes are recommended for judicious exercise of the lungs ? What will be the effect upon the blood if the movements of the ribs and diaphragm are restricted ? Show how the blood is imperfectly oxydated by restricting the movement of the ribs and diaphragm.

pass obliquely around the chest, and make their attachment much lower at the anterior than at the posterior extremity; and also that the central, curved portion of the ribs is lower than even their anterior extremity. As such is the relation of the ribs to the vertebræ and sternum, the latter cannot be elevated while the spinal column is stationary, without elevating the anterior extremity of the ribs, which elevation enlarges the thoracic cavity.

Fig. 119.

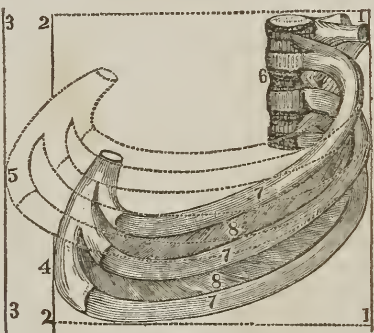


Fig. 119. 6, Four of the vertebræ, to which are attached three ribs, (7, 7, 7,) with their intercostal muscles, 8, 8. These ribs, in their natural position, have their anterior extremity at (4,) while the posterior extremity is attached to the vertebræ (6). 1, 1, and 2, 2, Two parallel lines, within which the ribs lie in their natural position. If the anterior extremity of the ribs be elevated from 4 to 5, they will not lie within the line 2, 2, but will reach to the line, 3, 3. If two bands extend from 1, 1, to 2, 2, they will effectually prevent the elevation of the ribs from 4 to 5, as the line 2, 2, cannot be moved to 3, 3.

The lower boundary of the thoracic cavity is formed by the diaphragm. This is attached at its margins to the lower extremity of the sternum, the cartilages, and extremities of the seven lower ribs, and to some of the lumbar vertebræ. The diaphragm is convex on its upper surface, and extends into the cavity of the chest.

The extension of the diameters of the lower part of the chest, by the elevation of the ribs and sternum, depresses the convexity of the diaphragm, and this depression is still farther

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What does fig. 119 represent? How is the lower portion of the thoracic cavity bounded? What depresses the convexity of the diaphragm? How is the convexity farther increased?

increased by the action of its muscular margin, which contracts simultaneously with the muscles that elevate the ribs and sternum. The simultaneous action of these muscles and the diaphragm results from their being supplied with nervous filaments from the same system of nerves. While the central portion of the diaphragm is depressed, the abdominal muscles are relaxed, and the abdominal organs are depressed, which produces an increased projection of the abdominal walls and organs.

Fig. 120.

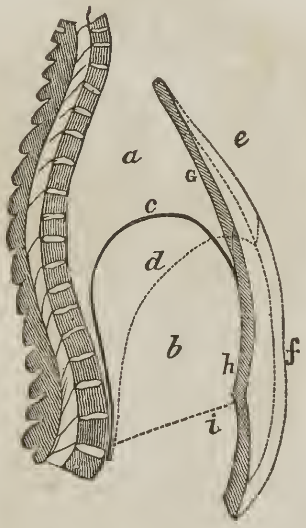


Fig. 120. *a*, The cavity of the chest. *b*, The cavity of the abdomen. *c*, The line of direction for the diaphragm when relaxed in expiration. *d*, The line of direction for the diaphragm when contracted in expiration. G, *h*, The position of the front walls of the abdomen and chest in inspiration. *e*, *f*, The position of the front walls of the chest and abdomen in inspiration. *i*, A band passing from the second lumbar vertebra to the abdominal muscles.

Let a tense band, *i*, fig. 120, extend from a lumbar vertebra to the abdominal muscles, when the diaphragm is at *c*,

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How is the simultaneous action of the intercostal muscles and diaphragm accounted for? What is the effect upon the abdominal organs when the diaphragm is depressed? Explain fig. 120.

and the abdominal muscles at *h*, and it will prevent the descent of the diaphragm to *d*, by restricting the movement of the muscles at *h*, from assuming their position at *f*.

Fig. 121.

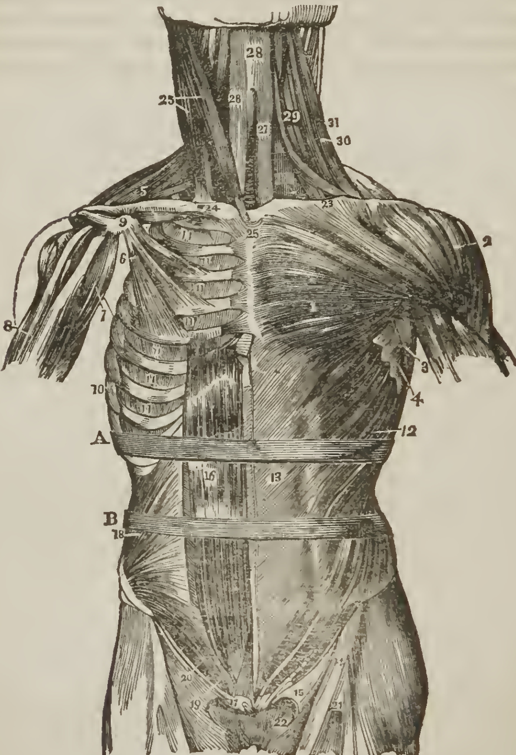


Fig. 121. 6, Represents the pectoralis minor muscle. 10, The serratus magnus. 25, The sterno-mastoideus. 26, The sterno-hyoideus. 27, The sterno-thyroideus. 28, The thyro-hyoideus. 29, The omo-hyoideus. 30, 31, The scalenus anticus and posticus. These several muscles, by their contraction, elevate the sternum and anterior extremity of the ribs. The muscles 11, 11, 11, 11, 11, 11, 11, (intercostals,) by their contraction, elevate the central portion of the ribs. The belt A, will prevent the elevation of the sternum and ribs, as before explained. The belt B, not only prevents the upward movement of the ribs, but will prevent the external oblique muscle, (13,) rectus (16,) and transverse, (18), from becoming protuberant in inspiration, which effectually obstructs the descent of the diaphragm.

Any inelastic band drawn closely around the lower part of the chest, or the abdomen, below the ribs, operates like the bands in the preceding illustration, in restricting the movement of the ribs. When any article of dress encircles either the chest or abdomen, so as to prevent an increase of its circumference, it has an injurious tendency, as it precludes the introduction of air in sufficient quantities to purify the blood. The question is not, — how much restriction of the respiratory movements can be endured, and life continue? but, — does any part of the apparel restrict these movements? If it does, it is a violation of the organic laws, and though nature is profuse in her expenditures, yet sooner or later she sums up her account.

In determining whether the apparel is worn too tightly, inflate the lungs, and if no stricture or pressure is felt, no injurious effects need be apprehended from this cause. In testing the closeness of the dress, some persons will contract to the utmost the abdominal muscles, and thus diminish the size of the chest, by depressing the ribs; when this is effected, the individual will exclaim, "How loose my dress is!" This practice is both deceptive and ludicrous. A full inflation of the lungs is a proper test.

If the brain be depressed by grief, tormented by anxiety, or absorbed in abstract thought, the contractile energy of the diaphragm and muscles that elevate the ribs, is much diminished, and the lungs are not so fully inflated as in a different condition of the brain. The frequency of respiration is also much less. By the influence of these two causes, the blood is but partially purified, and the whole system becomes enfeebled. This is not unfrequently followed by the deposition of tuberculous matter in different parts of the system, and the individual eventually dies of scrofula or consumption. This is exemplified in those individuals who have met with reverses of fortune, in which character and property were lost. Hundreds yearly die from the effect of depressed spirits. A striking instance is related by Lænnec. In a female religious establishment in France, great austerities were practised; the mind was absorbed in contemplating the terrible truths of

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What is the operation and effect of inelastic bands when drawn closely round the lower part of the thorax? How can we determine whether the apparel is too tightly worn? What is the effect when the brain is depressed by grief? Does the state of the brain exert an influence on respiration? What is the ultimate result? Give the instance related by Lænnec.

religion, and in mortifying the flesh. The whole establishment, in the space of ten years, was several times depopulated — with the exception of the persons employed at the gate, in the kitchen, and garden — with that fatal disease, consumption. This institution did not long continue, but was suppressed by order of the French government.

Respiration is more frequent in females and children than in adult men. In diseases, particularly those of the lungs, it is more increased in frequency than the action of the heart. In a state of rest, the number of respirations in a healthy man are from fourteen to eighteen in a minute. Usually the heart beats about four times to every respiration.

If a person respire eighteen times every minute, and inhale each time twenty cubic inches of air, there would be needed, to supply his wants, 518,400 cubic inches of air, or 300 cubic feet, every twenty-four hours.

During the interval of respiration, the change of the blood is still progressing in the lungs, as there is always a quantity of air remaining, which is called *residual* air.

3d. *The inhaled air should contain one fifth part of oxygen. At every inhalation, a portion of the oxygen permeates the vesicular membrane, and unites with the blood, which, at the same time, emits a certain amount of carbonic acid gas, which unfits the air to be respired a second time.*

A simple experiment will elucidate the vitiation of exhaled air. Breathe into a cup containing lime-water, and in a short time a white film will be seen on the surface of the water. This is called the carbonate of lime, and this alkaline salt is formed by the carbonic acid gas, from the exhaled air, uniting with the lime.

It is a well-known fact, that a taper will not burn where carbonic acid alone exists; and another proof that exhaled air contains carbonic acid gas, or will not support combustion, may be seen by the following experiment.

Take a glass receiver, to which is attached a stop-cock; sink it in water until it displaces the air by filling the receiver.

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In whom is respiration most frequent? How is it in diseases? How often do we respire in a minute? How often does the heart beat at every respiration? How many cubic feet of air do we inhale in twenty-four hours? How much oxygen should the inhaled air contain? Why? Why is air unfit to be re-inhaled? How can it be proved that the air exhaled contains carbonic acid gas? What experiment shows that exhaled air will not support combustion?

Gradually raise it, and respire into it, avoiding as much as possible the ingress of atmospheric air; then inhale the same air and sink the vessel into the water. Repeat this several times. Fill the receiver with the air that has been inhaled several times, and slide a plate upon which a sheet of paper is placed, under it, while the open mouth of the receiver is kept below the surface of the water. By turning the stop-cock, and keeping it on the plate filled with water, no atmospheric air will pass into the receiver. After a taper is lighted, raise and invert the jar suddenly, being careful to keep the mouth of the jar covered with the paper; then raise the paper and pass the burning taper into it; the flame will be immediately extinguished, for want of oxygen to support combustion, and in consequence of the presence of carbonic gas.

In crowded rooms, which are not ventilated, the air is soon vitiated by the abstraction of oxygen, and the deposition of carbonic acid gas, by the audience. The lamps, under such circumstances, emit but a feeble light. Let the oxygen gas be more and more expended, and the lamps will burn more and more feebly until nearly extinguished. Air in which lamps will not burn with brilliancy, is unfitted for respiration. For this reason, before entering wells or subterranean passages, a lighted taper should be passed into them, and if the flame be extinguished, it shows the presence of carbonic gas, and if such places are entered before this deleterious gas is removed, instant death will follow. Nor should persons sleep in rooms where charcoal is in a state of ignition, without some aperture to permit the carbonic acid gas to escape.

In addition to the above-mentioned sources, which render the air unfit for respiration a second time, there is passing from the skin and lungs, more than two pounds of waste matter every twenty-four hours. This is diffused through the air in the room, and if this impure air be not changed, it will be inhaled into the lungs.

Let the air become vitiated, whether from the abstraction of oxygen, an excess of carbonic gas, or the exhalations from the lungs and skin, and it will have a deleterious effect on the system, by rendering the circulating fluid impure. For this reason, in workshops, churches, and dwelling houses, pure air

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What effect has vitiated air upon burning lamps? What caution is given on entering subterranean passages? In sleeping in a close room where ignited charcoal is placed?

should be admitted freely and constantly, and the impure and vitiated air permitted to escape. This is of more importance than the warming of houses. We can compensate for the deficiency of a stove, by an extra garment or an increased quantity of food; but neither garment, exercise, nor food, will compensate for pure air.

The brain of the scholar must be stimulated by pure blood, or its proper functions will not be performed. If the schoolhouse be not ventilated, the pupils will complain of inability to study, defective memory, and headache, caused by a want of pure oxygenated blood, and an excess of carbonic acid gas.

Above all, the sleeping room should be so ventilated that the air in the morning, will be as pure as when retiring to rest in the evening. Ventilation of the room would prevent morning headaches, and the want of appetite, so common among the feeble. *Every* room should be so constructed that pure air can be admitted freely, as impure air tends to weaken and destroy the system. The impure air of sleeping rooms is probably more ruinous than intemperance. Look around the country, and those who are most exposed, who live in huts but little superior to the sheds that shelter the farmer's flocks, are found to be the most healthy and robust. Headaches, liver complaints, and coughs, are almost unknown to them; not so with those who spend their days and nights in rooms, in which the sashes of the windows are caulked, or perchance doubled, to prevent the keen but healthy air of winter from entering their apartments. Disease and suffering are their constant companions. The one breathes pure air, the other does not.

Due attention has not been given to the proper ventilation of rooms. 1st. Air can and should be introduced into our apartments *pure* and *warm*. This can be done by the use of hot-air furnaces, or by converting the box and air-tight stoves, into hot-air furnaces. The *common air-tight stoves* are very objectionable, especially for sick rooms.

2d. Provision should be made for the escape of the vitiated air, as well as the introduction of pure air. This can be done

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Is the ventilation of rooms of as much importance as the warming of them? Why should every inhabited room be well ventilated? How should pure air be introduced into apartments? How should the impure air be carried from rooms?

by constructing a ventilating flue in the chimney. This should be in contact with the flues for the escape of smoke, but separated from them by a thin brick partition. The heat of the current of air in the smoke flues will warm the separating brick partition, and consequently rarefy the air in the ventilating flue. Communication from every room in a house should be had to such flues. The draught of air can be regulated, by well-adjusted registers. Open fire places and open grates favor the escape of vitiated air, and are more conducive to health, than any of the ordinary stoves.

*Effects of impure blood upon the system will now be stated.* The blood may be rendered impure by each of the influences before described, or by all of them combined. We will note the effect it has upon the bones. As one condition of health and strength, they require pure blood. If it be not supplied to them, they will become soft and brittle; their vitality will be impaired; disease will be the ultimate result. The four hundred muscles receive another portion of the blood. These organs are attached to, and act upon the bones. Upon the health and contractile energy of the muscles depends the ability to labor. Give these organs of motion impure blood, which is an unhealthy stimulus, and they will become enfeebled, the step will lose its elasticity, the movement of the arm will be inefficient, and every muscle will be incapacitated to perform its usual amount of labor.

The stomach, liver, and other organs subservient to the digestion of food, are supplied with this impure blood. This impairs the digestive process, causing a faintness of the stomach, loss of appetite, and a deranged state of the intestines, and, in general, all the symptoms of dyspepsia, or liver complaint. This impure blood goes also to the lungs, in the *nutrient* arteries. The delicate structure of these organs, in which the blood is, or should be purified, needs the requisite amount of pure blood to give them vigor and health. The blood not becoming of that character, the lungs themselves lose their tone, and even if permitted to expand freely, have not power fully to change in inspiration the impure quality of the blood. This dark, sluggish fluid also passes to the skin, the health and beauty of which require well-purified blood.

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Mention how impure blood affects the bones and muscles of the system. The digestive organs. Does this impure blood affect the structure of the lungs? How conveyed?

This not existing, the surface becomes covered with pimples and blotches, and the individual suffers from "humors" as they are called. Drinks, made of various kinds of herbs, and pills and powders, are taken for this disease. These will never have any good effect, while the causes of impure blood exist.

This impure blood is sent to the brain. If this important organ be stimulated by impure blood, the nervous headache, bilious headache, and all kinds of aches, confusion of ideas, loss of memory, impaired intellect, dimness of vision, and dullness of hearing, will be experienced. Often, in process of time, the brain becomes disorganized, and the brittle thread of life is broken.

The free movements of the ribs and diaphragm, with an abundant supply of pure air, are of the utmost importance to feeble and scrofulous individuals. A common cause of scrofula, so prevalent in the densely populated sections of our country, is the inhalation of vitiated air. Due renovation of the air which we breathe, is really influential in protecting us against the inroads of disease. A constant circulation of air is one of the most effectual means of preventing contagion from fever. It is no unusual practice in some communities, when a child or an adult is sick of an acute disease, to prevent the ingress of pure air, simply from the apprehension of the attendants, that the patient will contract a cold. Again, the prevalent custom of several individuals sitting in the sick-room, particularly when they remain there for several hours, tends to vitiate the air, and consequently to increase the suffering and danger of the sick person. In fevers, or inflammatory diseases of any kind, let the patient have pure air to breathe, for the purer the blood, the greater the power of the system to remove disease, and the less the liability to contract colds.

Fig. 122 represents the thoracic and abdominal organs, in their relative positions. Let the pupil, from this figure, review the sections upon the anatomy and physiology of the digestive and respiratory organs, giving the location of each part, describing its structure, use, and the laws upon which health depends.

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How is the skin affected by it? How does it affect the brain? What is a common cause of scrofula? What is one of the means of preventing contagion from fever? What custom prevalent in many sick-rooms should be abandoned? What does fig. 122 exhibit?

Fig. 122.

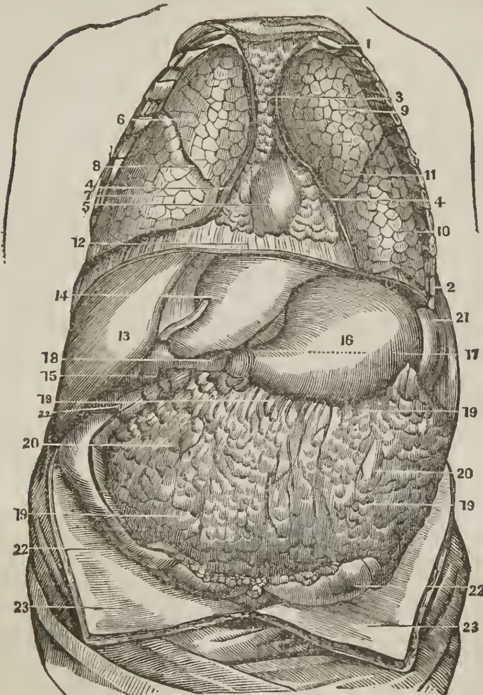


Fig. 122. A view of the organs of the chest and abdomen, in their natural position, as given by the removal of the anterior walls of each cavity. 1, 2, The ribs forming the side of the chest. 3, The fatty tissue in the anterior mediastinum. 4, 4, The section of the pleura of each side. 5, The pericardium, enclosing the heart. 6, The superior lobe of the right lung. 7, The inferior lobe of the right lung. 8, The fissure that separates them. 9, The upper lobe of the left lung. 10, The lower lobe of the left lung. 11, The fissure between them. 12, A transverse section of the diaphragm. 13, The upper face of the right lobe of the liver. 14, The left lobe of the liver. 15. The end of the gall bladder. 16, The stomach. 17, The pylorus. 18, The duodenum. 19, 19, 19, 19, The omentum. 20, 20, The convolutions of the small intestines seen through the omentum. 21, The spleen. 22, 22, 22, The large intestines. 23, 23, The walls of the abdomen turned down.

# CHAPTER VIII.

## THE VOICE.

The voice consists in the production of a particular sound, by the aid of the air which escapes from the lungs. It is chiefly formed in that portion of the respiratory organs named the *larynx*. Incidentally, the other portions of the respiratory organs are subservient to phonation or sound. The tongue, nasal passages, muscles of the fauces and face, are agents which aid in the intonations of the voice. The mechanism and function of the larynx, will be the topics examined in this chapter.

### ANATOMY OF THE LARYNX.

Fig. 123.

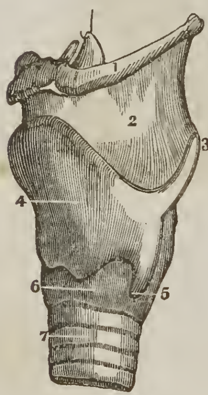


Fig. 124.

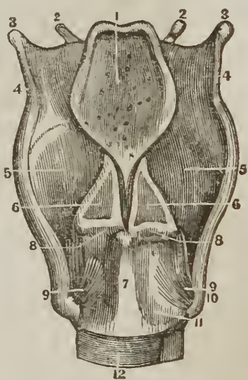


Fig. 123. Represents a lateral view of the cartilages and ligaments of the larynx. 1, The os hyoides. 2, A ligament which connects the hyoid bone with the thyroid cartilage. 3, The large horn of the thyroid cartilage. 4, The angle and side of this cartilage. 5, The small horn of this cartilage. 6. The lateral portion of the cricoid cartilage. 7, Rings of the trachea.

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*What is the voice?* In what organ is it chiefly formed? Name other organs that are subservient to sound. What do Figs. 123 and 124 represent?

Fig. 124. Represents a posterior view of the cartilages and ligaments of the larynx. 1, The posterior face of the epiglottis. 2, 2, The appendages of the os hyoides. 3, 3, Its cornua, or horns. 4, 4, The lateral ligaments which connect the os hyoides and thyroid cartilage. 5, 5, The posterior face of the thyroid cartilage. 6, 6, The arytenoid cartilages. 7, The cricoid cartilage. 8, The articulation of the cricoid and arytenoid cartilages. 9, 9, The posterior ligament that connects the cricoid and thyroid cartilages. 10, The small horn of the thyroid cartilage. 11, The anterior ligament that connects the cricoid and thyroid cartilage. 12, The ligamentous portion of the first ring of the trachea.

The LARYNX is a kind of cartilaginous tube, which, taken as a whole, has the general form of a hollow reversed cone, with its base upward toward the tongue, in the shape of an expanded triangle. It opens into the pharynx, and unites inferiorily to the trachea.

The walls of the larynx are chiefly formed by the union of five cartilages, viz: the *thyroid*, *cricoid*, the two *arytenoid*, and the *epiglottis*. These are bound together by ligaments, and moved by muscles.

Fig. 125.

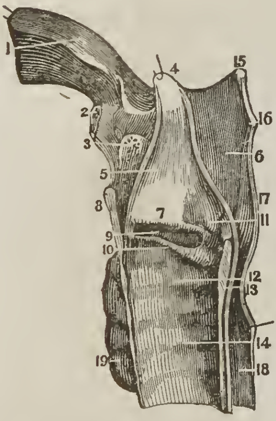


Fig. 126.

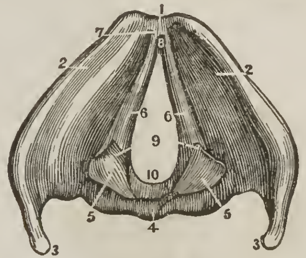


Fig. 125. Represents a vertical section of the larynx. 1, A section of the root of the tongue. 2, The os hyoides. 3, The muciparous glands of the epiglottis. 4, The top of the epiglottis cartilage. 5, A section of its anterior face. 6, A fold of mucous membrane. 7, The superior vocal ligament. 8, A section of the thyroid cartilage. 9, The ventricle of the larynx. 10, The lower vocal ligament. 11, The arytenoid cartilages. 12, Inside of the cricoid cartilage. 13, Its posterior portion. 14, The lining membrane of the trachea. 15, The end of the cornu major of the os hyoides. 16, The cornu major of the thyroid cartilage. 17, The mucous membrane of the pharynx. 18, The œsophagus. 19, The thyroid gland.

Fig. 126. Represents a view of the larynx from above, showing the vocal ligaments. 1, The superior edge of the larynx. 2, 2, Its anterior face. 3, 3, The cornua major

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Describe the larynx. How are its walls formed? How are these cartilages bound together and moved?

of the thyroid cartilage. 4, The posterior face of the thyroid cartilage. 5, 5, The arytenoid cartilages. 6, 6, The vocal ligaments. 7, Their origin, within the angle of the thyroid cartilage. 9, Their termination, at the base of the arytenoid cartilages. 8, 10, The glottis.

The *vocal cords*, or ligaments, are formed of elastic and parallel fibres, enclosed in a fold of mucous membrane. They are about two lines in width, and pass from the anterior angle of the thyroid cartilage to the two arytenoid cartilages. The one is named the superior, and the other the inferior vocal ligament. The cavity or depression between the superior and inferior ligament, is named the ventricle of the larynx. The aperture or opening between these ligaments or vocal cords, is named the *glottis*, or *chink of the glottis*. It is about three fourths of an inch in length, and one fourth of an inch in diameter, the opening being widest at the posterior part. This opening is enlarged and contracted by the agency of the different laryngeal muscles.

The cartilages of the larynx have attached to them, and are acted upon by, eight pairs of small muscles. Several of these muscles are well represented in the following engravings.

Fig. 127.

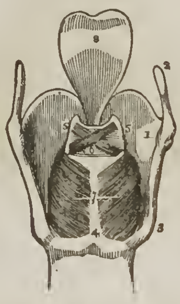

Fig. 128.

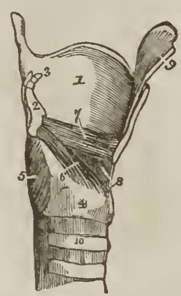

Fig. 127. Represents a posterior view of the larynx. 1, The thyroid cartilage. 2, One of the ascending cornua. 3, One of the descending cornua. 4, The cricoid cartilage. 5, 5, The arytenoid cartilages. 6, The arytenoideus muscle, consisting of oblique and transverse fibres. 7, The crico-arytenoideus-postici muscles. 8, The epiglottis.

Fig. 128. Represents a side view of the larynx. 1, The thyroid cartilage. 2, One of the arytenoid cartilages. 3, One of the cornua of the larynx. 4, The cricoid car-

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Describe the vocal cords. How named? What is the name of the cavity between the superior and inferior ligaments? Where do we find the chink of the glottis? How wide is the glottis? How long? How is this opening enlarged and contracted? How many muscles act upon the cartilages of the larynx?

tilage. 5, The crico-arytenoideus-posticus muscle. 6, The crico-arytenoideus-lateralis muscle. 7, The thyro-arytenoideus muscle. 8, The crico-thyroidean membrane. 9, The epiglottis. 10, The upper part of the trachea.

In fig. 127, The muscle 7 opens the chink of the glottis. The muscle 6 closes the chink of the glottis.

In fig. 128, The muscles 6 and 7 open the chink of the glottis.

The larynx is connected by muscles with the sternum, œsophagus, base of the skull, hyoid bone, lower jaw, and tongue. The following engravings illustrate this connection.

In addition to the parts before described, the larynx is supplied with a large number of blood-vessels. It likewise receives nerves from the ganglionic system, and two large nerves from the eighth pair. The number and size of the nervous filaments distributed to the mucous membrane of the larynx, render it more sensitive than any other portion of the respiratory passages.

Fig. 129.

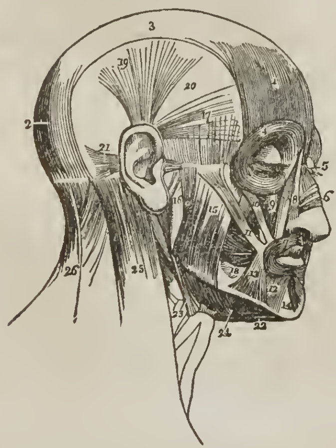


Fig. 129. A view of the superficial muscles of the face and head. 1, The frontal portion of the occipito-frontalis. 2, Its occipital portion. 3, Its aponeurosis. 4, The orbicularis palpebrarum. 5, The pyramidalis nasi. 6, The compressor nasi. 7, The orbicularis oris. 8, The levator labii superioris alæque nasi. 9, The levator superioris proprius. 10, The zygomaticus major. 11, The zygomaticus minor. 12, The depressor labii inferioris. 13, The depressor anguli oris. 14, The levator labii inferioris. 15 and 16, The masseter. 17, The attrahens aurem. 18, The buccinator. 19, The attollens aurem. 20, The fascia of the temporal muscle. 21, The retrahens aurem. 22, The belly of the digastric muscle. 23, The stylo-hyoideus muscle. 24, The mylo-hyoideus muscle. 25, The upper part of the sterno-cleido-mastoideus muscle. 26, The upper part of the trapezius.

With what is the larynx connected? Why is the larynx more sensitive than other parts of the respiratory passages?

The muscles 8 and 9, elevate the upper lip. 12, The muscle that depresses the lower lip. 10, and 11, The muscles that elevate the angle of the mouth. 13, The muscle that depresses the angle of the mouth. 7, The muscle that closes the mouth. 15 and 16, The muscles that bring the upper and lower jaw in opposition, in masticating food. 25, The muscle that brings the head forward in bowing. 4, The muscle that closes the eye.

Fig. 130.

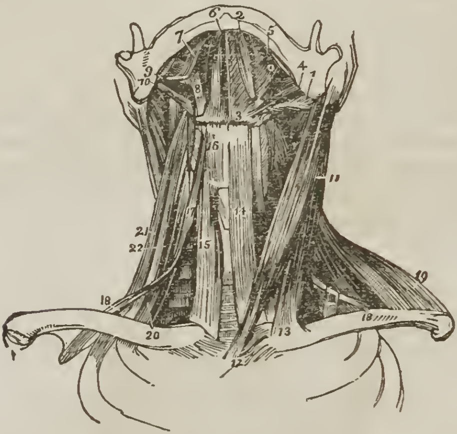


Fig. 130, Exhibits the muscles of the anterior aspect of the neck. On the left side the superficial muscles are seen; on the right, the deep. 1, The posterior belly of the digastricus muscle. 2, Its anterior belly. 3, The os hyoides, to which is attached the pulley, (o) through which the tendon of the digastricus passes. 4, The stylo-hyoideus muscle. 5, The mylo-hyoideus. 6, The genio-hyoideus. 7. The tongue. 8, The hyo-glossus muscle. 9, The stylo-glossus. 10, The stylo-pharyngeus. 11, The sterno-cleido-mastoideus muscle. 12, 13, Its sternal and clavicular origin. 14, The sterno-hyoideus. 15, The sterno-thyroideus. 16, The thyro-hyoideus. 17, 18, The omo-hyoideus. 19, The trapezius. 20, The scalenus anticus. 21, The scalenus posticus. 22, The scalenus medius.

The muscles 1, 2, 4, 5, and 6, elevate and draw forward the hyoid bone when the lower jaw is fixed, or depress the jaw when the os hyoides is fixed. The muscles 11, 14, 15, and 16, elevate the sternum when the os hyoides is fixed, or depress this bone and the larynx when the sternum is fixed. When these two sets of muscles act together, the larynx is projected forward. The muscles 20, 21, and 22, elevate the first rib.

## PHYSIOLOGY OF THE LARYNX.

In the formation of the voice, each of the portions before described performs an important part. The cricoid and thyroid cartilages give form and stability to the organs; the arytenoid cartilages by their movement vary the width of the glottis. The epiglottis is flexible and elastic. When it is erect, the chink of the glottis is open, as in inspiration;

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Which cartilages give stability and form to the larynx? Which vary the diameter of the glottis? What is the function of the epiglottis?

when depressed, as in swallowing food and drink, it covers and closes this aperture. This prevents the introduction of articles of food into the air-passages, and, probably, modifies the sounds as they issue from the glottis.

Fig. 131.

Fig. 131. A lateral view of the tongue, larynx and upper part of the trachea. 1, A portion of the temporal bone of the left side. 2, 2, The right side of the lower jaw; the left side has been removed. The white line shows the position of the lower margin of the jaw behind the muscles. 3, The tongue. 4, The genio-hyoideus muscle. 5, The genio-hyo-glossus. 6, 7, The hyo-glossus. 8, A portion of the lingualis. 9, The stylo-glossus. 10, The stylo-hyoideus. 11, The stylo-pharyngeus. 12, The os-hyoides. 13, The membrane connecting the hyoid bone with the thyroid cartilage. 14, The thyroid cartilage. 15, The thyro-hyoideus muscle. 16, The cricoid cartilage. 17, The membrane which connects the cricoid and thyroid cartilages. 18, The trachea. 19, The commencement of the œsophagus.

The muscle 4 elevates the larynx, and draws it forward, when the under jaw is fixed, or it depresses the under jaw when the larynx is fixed. The muscles 6, 7, elevate the larynx or depress the root of the tongue, when the larynx or tongue operates as the fixed point. The muscles 10 and 11 draw the larynx upward and backward. The muscle 9 draws the root of the tongue upward and backward. The muscle 15 draws the larynx toward the hyoid bone, or this bone toward the larynx, as the one or the other is fixed by the action of other muscles.

The muscles of the neck elevate and depress the larynx; the laryngeal muscles (Figs. 127, 128) increase or diminish the width of the glottis; at the same time, the vocal cords which vary the vocal sounds, are relaxed or tightened, while the muscles of the face open and close the mouth.

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By what means are the vocal sounds varied?

It is now proved, beyond a doubt, that the vocal cords are the principal agents in the formation of the voice. The tongue, which many have supposed to be the most important organ in speaking, is not essential to sound, as in some cases of the removal of the tongue the persons thus mutilated could speak with fluency.

Sound depends on the forcible ejectment of air from the chest, through the chink of the glottis. The velocity of the expelled current of air and the tension of the vocal ligaments, are the principal circumstances that modify the character of sound. The size of the larynx, the volume and health of the lungs, the condition of the fauces and nasal passages, the elevation and depression of the chin and tongue, the development and freedom of action of the muscles which connect the larynx with the sternum, hyoid bone, lower jaw, tongue, and the opening of the mouth, contribute to the modulations of sound.

The development of the vocal organs, their education and use, will be the subject of the following observations.

## PRACTICAL SUGGESTIONS.

The larynx is much more developed and prominent in man than in woman. In the former, the anterior angle of the thyroid cartilage is acute, while in the latter it is rounded, and the central slope of the superior border of the same cartilage is less deep, and the epiglottis smaller and less prominent than in man.

Less striking difference exists in the formation of the larynx in infancy, but at a later period it is more developed in the male than in the female. It is very remarkable that this increase is not progressive, like that of other organs, but, on the contrary, developes itself at once at the period of puberty.

Common observation shows that the voice can be changed and modified by the habits; sailors, smiths, and others, who are engaged in noisy occupations, exert their vocal organs more strongly than those of more quiet pursuits. This not only affects the structure of the vocal organs, but varies their intonation.

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What are the essential agents in speaking? Is the tongue essential in speaking? On what does sound depend? What difference between the formation of the larynx of the female and that of the male? Does this difference exist in childhood? Is its development progressive? Is the voice changed or modified by the habits? Give an instance. What is the effect?

The voice is strong in proportion to the development of the larynx, and the capacity of the chest. This points to the necessity not only of exercising the larynx, chest, and upper part of the abdomen, but also of dressing loosely.

Fig. 132. Fig. 133.

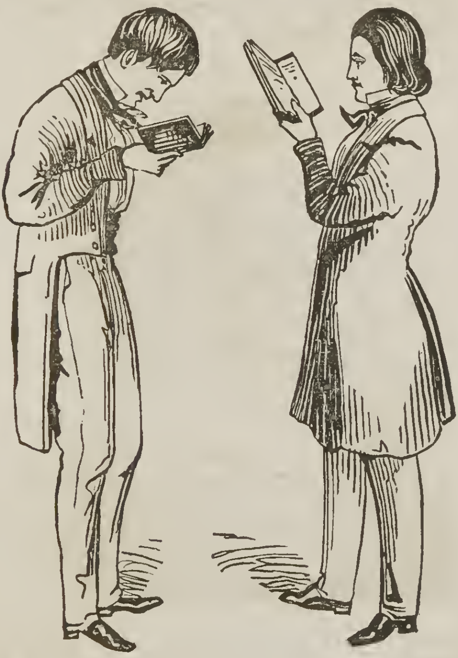

Fig. 132. Represents an improper position; but one not unfrequently seen in some of our common schools, and in some of our public speakers.
Fig. 133. Represents the proper position for reading, speaking, and singing.

The attitude also affects the modulation of the voice. When an individual stands erect, the movements of the whole respiratory apparatus are most free and effective. The larynx is brought forward, by the erect position of the head, and the

On what does the strength of the voice depend? What does this point to? What do Figs. 132 and 133 exhibit? Has the attitude any effect in the modulations of the voice?

elevation of the chin. These operations are effected by the tension of the muscles that connect the larynx with the lower jaw and sternum. The laryngeal muscles are then brought to a proper relation for action, by which a tension of the vocal cords is produced, that favors a clear and harmonious enunciation. Hence, children and adults should stand erect in speaking, reading, or singing.

Fig. 134.

If an individual or class read or sing, when sitting, let the position represented in Fig. 135, be adopted, and not the one represented in Fig. 134; for the erect position in sitting, favors the free and effective action of the respiratory and laryngeal organs, and is as important as the erect attitude when standing.

As pure air is more elastic and resonant than impure, and as easy, melodious speaking or singing requires atmospheric elasticity, so school-rooms and singing-halls should be well ventilated, if we would be entertained with soft intonations in

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Why is the erect position preferred in standing? What does Fig. 134 exhibit?

reading, or sonorous singing. The imperfect ventilation of churches and vestries is the most fruitful cause of weakness and loss of voice among clergymen. This is almost unknown among clergymen who speak in very open rooms, where stoves are not used.

Fig. 135.

The sound of the voice is modified, and enunciation rendered more or less distinct, in proportion as the jaws are separated in speaking, and the fauces and nasal passages are free from obstruction. For these reasons, the scholar should be taught to open the mouth when reading, speaking, or singing, that the sounds formed in the larynx and modified in the fauces may have an unobstructed egress. If the fauces are obstructed by enlarged tonsils, a condition by no means uncommon in children, they should be removed by a surgical operation, which is not only effective, but safe, and not painful. These tonsils are situated on each side of the root of the tongue, and when enlarged they obstruct the passage through

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Give a reason why school-houses and singing-halls should be well ventilated. What does Fig. 135 exhibit? Name an influence which induces clear enunciation.

which the air passes to and from the lungs, which renders the respiration not only laborious but distressing.

If the muscles of the neck and larynx are compressed by a high cravat, or other close dressing, their movements will be impeded and the power of making sounds diminished. Therefore, the clothing of the neck, particularly of *public speakers* and *singers*, should be loose. The clothing should be not only loose, but thin; as when the vocal organs are used, a warm dress upon the neck will induce too great a flow of blood to these parts, which will be attended by subsequent debility. The warm and close dressing of the neck while speaking, is a common cause of loss of voice, improperly called *bronchitis*,— a disease very prevalent among clergymen. (The affection is not of the bronchi, but of the larynx.)

The varied tones in speaking and singing, are caused by different degrees of tension in the vocal cords, and different conditions of the auxiliary organs. The different conditions of the vocal apparatus, are produced by various degrees of contraction of the muscles of the larynx and neck. To induce a state of these muscles suited to produce a certain intonation in speaking or singing, requires practice, or, in other words, education of the muscles. The successful mode of training the vocal organs, is similar to that adopted in learning to dance, or to play the piano. When a child learns to dance, in making the different steps, he calls into action certain muscles. At the commencement, these steps are made in a stiff and ungraceful manner. Much effort is also required to assume the different positions. By repeated contraction of the muscles, the movements become more ready and graceful, while the labor and effort of dancing are diminished. The same is true in learning to play any musical instrument, or in acquiring skill in the use of tools in mechanical pursuits.

Hence, let there be an effort made to induce a proper state of the vocal organs, to produce a particular sound. Let this effort be repeated again and again for a short period. After relaxing or resting the organs, call them again into action. Let there be repetition, until all the parts of the vocal apparatus can be called into ready and harmonious action. This

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What is the effect of a high cravat, or close dressing of the neck? What is a common cause of bronchitis among clergymen and other public speakers? How are the varied tones in singing produced? Must the vocal organs be trained, in order to produce a particular sound? How effected?

repetition is as necessary in learning to read as in singing or writing. Practise a child a long time in pronouncing syllables and words, before you begin to teach it to read sentences. There is nothing gained, in the attempt to instruct a child to pronounce the letters of the alphabet, before the vocal organs are so developed that distinct utterance can be given to the proper sounds.

No part of the vocal organs is wanting, with those individuals that stammer, or who have an impediment in their speech. Some parts may be more developed than others. Generally, however, some parts are but imperfectly under the control of the will. Such portions of the vocal organs will assume an irregular and rapid movement, while other parts, the movements of which are essential, remain comparatively inactive. This can be seen by comparing the movements of the lips, tongue, and larnyx, while attempting to speak, in a person who stammers, with the movements of the corresponding parts, while speaking, in an individual who has no such impediment. Surgical operations and medical treatment, are not highly advantageous in a majority of these cases. In the young and middle aged, this defect can be removed by *patient* and judicious training. Let such sounds be made and such words be uttered as can be made and uttered with distinctness. Let there be repetition, until the words can be spoken at any time with readiness. Then take for a lesson other words and sounds more difficult, and pursue a similar process of training and repetition, until each portion of the vocal organs can be called into a ready and harmonious action in giving utterance to any word in common use.

"The organs of the voice, in common with all other parts of the bodily frame, require the vigor and pliancy of muscle, and the elasticity and animation of mind, which result from good health, in order to perform their appropriate functions with energy and effect. But these indispensable conditions to the exercise of vocal organs, are, in the case of most learners, very imperfectly supplied. A sedentary mode of life, the want of invigorating exercise, close and long-continued application of mind, and, perhaps, an impaired state of health, or a feeble constitution, prevent, in many instances, the free and forcible use of those muscles on which voice is dependent.

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Should a child practise enunciation a long time? Why? How is stammering to be corrected?

Hence arises the necessity of students of elocution practising physical exercises adapted to promote general muscular vigor, as a means of attaining energy in speaking; the power of any class of muscles, being dependent on the vigor of the whole system.

"The art of cultivating the voice, however, has, in addition to the various forms of corporeal exercise, practised for the general purpose of promoting health, its own specific prescriptions for securing the vigor of the vocal organs, and modes of exercise adapted to the training of each class of organs separately.

The results of such practice are of indefinite extent. They are limited only by the energy and perseverance of the student, excepting perhaps in some instances of imperfect organization. A few weeks of diligent cultivation are usually sufficient to produce such an effect on the vocal organs, that persons who commence practice with a feeble and ineffective utterance, attain, in that short period, the full command of clear, forcible, and varied tone.

Gymnastic and calisthenic exercises are invaluable aids to the culture and development of the voice, and should be sedulously practised when opportunity renders them accessible. But even a slight degree of physical exercise, in any form adapted to the expansion of the chest and to the freedom and force of the circulation, will serve to impart energy and glow to the muscular apparatus of voice, and clearness to its sound. There is, therefore, a great advantage in always practising some preliminary muscular actions, as an immediate preparation for vocal exercises."

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On what does forcible and energetic speaking depend? What twofold effect arises from the cultnre of the voice? Is the art of cultivating the voice limited? What are invaluable aids in cultivating the voice? Is it advantageous before vocal exercise to call the muscles into action?

# CHAPTER IX.

## THE CIRCULATORY SYSTEM.

THE fluid of the system, termed *blood*, is carried to and from the different parts of the system, by the agency of the *heart*, *arteries*, *veins*, and *capillaries*. Each of these make a part of the circulatory system.

### ANATOMY OF THE HEART.

The HEART is placed obliquely in the left cavity of the chest, the base being directed upwards and backwards, towards the right shoulder, while its apex points forward to the left, about three inches from the sternum to the space between the fifth and sixth ribs. Its under side rests upon the tendinous portion of the diaphragm.

The heart is surrounded by a sac, called the *pericardium*, or heart-case. The interior surface of this membrane secretes a serous fluid, that lubricates the exterior of the heart, and obviates friction between it and the pericardium. In health, there is usually about a tea-spoonful of this fluid; in disease it sometimes amounts to several ounces, causing what is called dropsy of the heart.

The heart usually weighs from eight to ten ounces. It is composed of muscular fibres, that traverse it in different directions, some longitudinally, but most of them in a spiral direction.

The human heart, like that of the sheep and of the ox, is a double organ; or it is divided into two parts or sides, — the

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*Through what agency is the circulation of the blood effected?* What is the position of the heart in the chest? In what direction is its base? Its apex? Upon what does its under side rest? What is the sac called which surrounds it? What is its use? What amount of fluid does this sac contain in health? When there is too great an accumulation of fluid what is the disease called? What is the usual weight of the heart? Of what is it composed? In what direction do the fibres run? Is there a similarity between the heart of man and that of the lower animals?

right and the left. The compartments of the two sides are separated by a septum or partition.

Fig. 136.

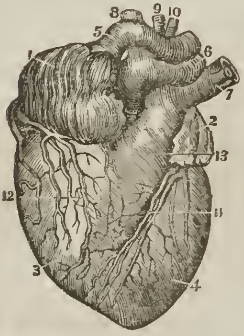


Fig. 137.

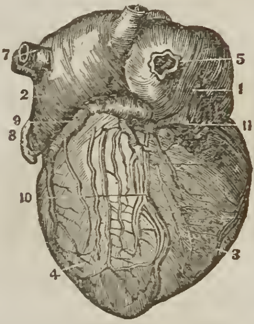


Fig. 136. An anterior view of the heart in a vertical position, with its vessels injected. 1, The right auricle. 2, The left auricle. 3, The right ventricle. 4, The left ventricle. 5, The descending vena cava. 6, The aorta. 7, The left pulmonary artery. 8, The arteria innominata. 9, The left primitive carotid artery. 10, The left subclavian artery. 11, The anterior cardiac vessels in the vertical fissure. 12, The posterior vessels in the transverse fissure. 13, The main trunk of the pulmonary artery.

Fig. 137. A posterior view of the heart in a vertical position and with its vessels injected. 1, The right auricle. 2, The left auricle. 3, The right ventricle. 4, The left ventricle. 5, The ascending vena cava. 6, The right posterior pulmonary vein. 7, The left posterior pulmonary vein. 8, The end of the left auricle. 9, The great coronary vein. 10, The posterior cardiac vessels in the vertical fissure. 11, The same in the transverse fissure.

The right side of the heart is divided into two parts, named the *auricle* and the *ventricle*. The auricle is called by butchers the deaf ear. Its walls are thinner, and paler in color than than those of the ventricle. The ventricles have upon their internal surface, pillars of flesh, named columnæ carneæ. These columns can be seen upon the interior of the hearts of domestic animals. The walls of the left ventricle in the heart in man are much thicker than those of the right, and the same is true of domestic animals. This is illustrated by comparing the thickness of the walls of the left side with those of the right side. See Figs. 138, 139, 140, 142.

Between the auricle and ventricle, on the right side, there are three folds of thin, triangular membrane, named the tri-

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Describe Figs. 136, 137. How is the right side of the heart divided? What is the auricle called by butchers? How does the auricle differ from the ventricle? What have the ventricles upon their internal surface? What is situated between the auricle and ventricle of the right side of the heart?

cuspid valves. There are seen passing from the floating edge of these valves to the columnæ carneæ, small white cords, named the chordæ tendineæ.

Fig. 138.

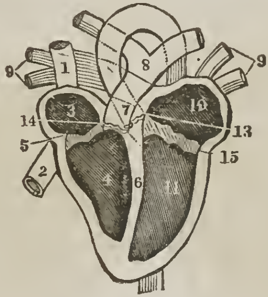


Fig. 138. A view of the heart with its several chambers, and the vessels in connection with them. 1, The superior vena cava. 2, The inferior vena cava. 3, The right auricle. 4, The right ventricle. 5, The situation of the tricuspid valves. 6, The partition between the two ventricles. 7, The pulmonary artery. 8, The point where it divides into the right and left pulmonary artery for the corresponding lungs. 9, 9, The four pulmonary veins, that bring the blood into the left auricle (10.) 11, The left ventricle. 15, The situation of the mitral valves. 13, The situation of the sigmoid valves of the aorta. 14, The situation of the sigmoid valves of the pulmonary artery.

From the right ventricle the venous blood passes through the pulmonary artery to the lungs. At the commencement of this artery there are placed three valves, called the sigmoid, or semi-lunar valves of the pulmonary arteries.

Between the auricle and ventricle of the left side of the heart there are two valves, named mitral. These are as much thicker and stronger than the tricuspid valves, as the contractile power of the thick walls of the left ventricle exceeds that of the right ventricle. To the free margins of these valves are attached small, tendinous cords, that connect them with the fleshy pillars upon the interior of the ventricle.

From the left ventricle proceeds the large systemic artery, named the aorta, through which the arterial blood passes to

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Describe Fig. 138. What passes from these valves to the columnæ carneæ? Describe the course of the blood from the right ventricle. What are found at the commencement of the pulmonary artery? What are the names of the valves between the auricle and ventricle of the left side of the heart? What are attached to these valves? What vessel passes from the left ventricle of the heart?

the whole system. At the junction of this artery with the ventricle there are three valves, called sigmoid or semi-lunar valves of the aorta. They receive their name from their form.

Fig. 139.

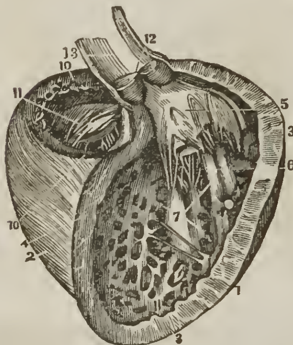

Fig. 140.

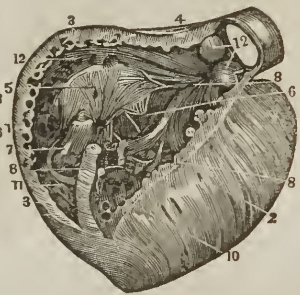

Fig. 139. A view of the interior of the right ventricle, a part having been removed, but the left ventricle is entire. 1, A section of the walls of the right ventricle. 2, The left ventricle. 3, The thickness of the walls of the right ventricle. 4, Thickness at the commencement of the pulmonary artery. 5, The anterior fold of the tricuspid valve. 6, A portion of the right ventricle untouched. 7, 8, The columnæ carneæ of the right ventricle with their chordæ tendineæ. 9, The right side of the ventricular partition. 10, 11, The cavities between the bases of the columnæ carneæ. 12, The depression leading to the pulmonary artery. 13, The interior of the pulmonary artery. Two of the sigmoid valves are seen; the third has been removed.

Fig. 140. A three-quarter view of the left ventricle after the removal of its anterior walls. 1, The outer side of the left ventricle. 2, The outer side of the right ventricle. 3, The thickness of its outer walls. 4, The thickness of a section near the side of the right ventricle. 5, The mitral valve. 6, 7, Two of the columnæ carneæ with their chordæ tendineæ, as attached to the valve. 8, The thickness of the ventricular walls at the origin of the aorta. 9, The cavity of the aorta. 10, 10, A section of the superior surface of the right ventricle, showing the opening of the descending vena cava and tricuspid valve from above. 11, The tricuspid valve. 12, The semi-lunar valves of the aorta.

The capacity of the ventricles of the heart is nearly the same; yet, as the walls of the left side of the heart are thicker than those of the right, their contractile energy varies to a considerable degree. The thinner walls of the right side possess, in health, power sufficient to impel the circulating fluid into the delicate and yielding lungs. The left side, from the greater thickness of its walls, is adapted to force the blood into the more dense structure of the general circulatory system.

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How many valves are there at the junction of this artery with the ventricle? Describe Figs. 139, 140. How does the capacity of the ventricles compare with each other? Why does the contractile energy of the right and of the left sides of the heart vary?

Fig. 141.

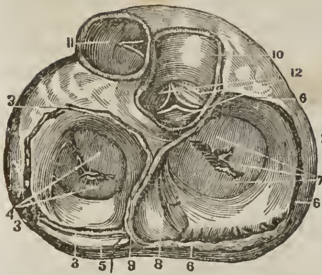


Fig. 142.


Fig. 141. A vertical view of the valves of the heart, as given by a section of the organ and arteries above the valves. 1, A depression in the left auricle. 2, A depression of the right auricle. 3, 3, 3, A section of the walls of the left auricle. 4, The superior face of the two folds of the mitral valve. 5, A section of the great coronary vein. 6, 6, A section of the walls at the base of the right auricle. 7. The superior face of the three folds of the tricuspid valve. 8. The orifice of the great coronary vein. 9, The partition between the right and left auricles. 10, A section of the aorta to show its sigmoid valves. 12, Its sigmoid valves. 11, The pulmonary artery with its sigmoid valves.

Fig. 142. A transverse section of the top of the ventricles just below the base of the auricles. 1, 1, A section of the right ventricle. 2, The opening between the right auricle and ventricle. 3, The largest fold of the tricuspid valve. 4, The depression to direct the blood to the pulmonary artery. 5, The funnel-shaped enlargement near the pulmonary artery. 6, A section of one of the columnæ carneæ attached by the chordæ tendineæ to the tricuspid valve. 9, A section of the external walls of the left ventricle. 10, A section showing the thickness of the portion between the ventricles. 11, The opening between the left auricle and ventricle. 12, The mitral valves. 13, The opening from the left ventricle into the aorta. 14, The columnæ carneæ of the mitral valve.

The heart is supplied with arteries and veins, which ramify between its muscular fibres, through which its *nutrient* blood passes. It has, likewise, a few absorbents, and many small nervous filaments from the sympathetic system of nerves.

## ANATOMY OF THE ARTERIES.

The ARTERIES are the cylindrical tubes, which convey the blood from the heart to every part of the system. They are dense in structure, and preserve, for the most part, the cylindrical form, when emptied of their blood, which is their condition after death. They were considered by the ancients as the vessels for the transmission of vital spirits, and were therefore named *arteries*, signifying *to contain air.*

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What do Figs. 141, 142 exhibit? How is the heart nourished? Is it also supplied with absorbents and nervous filaments? *Describe the arteries.* What function did the ancients suppose them to perform?

Arteries are composed of three coats. The external or cellular coat is firm and strong; the middle, or fibrous coat, is composed of yellowish fibres. This coat is elastic, fragile, and thicker than the external coat. Its elasticity enables the vessel to accommodate itself to the quantity of blood it may contain. The internal coat is a thin serous membrane, which lines the interior of the artery, and gives it the smooth polish which that surface presents. It is continuous with the lining membrane of the heart.

The arteries do not terminate directly in veins, but in an intermediate system of vessels, which, from their minute size, are called capillaries. Communications between arteries are free and numerous. They increase in frequency with diminution in the size of the branches, so that through the medium of the minute ramifications, the entire body may be considered as one circle of inosculation, or anastomoses.

The arteries, in their distribution through the body, are enclosed in a loose, cellular investment, called a sheath, which separates them from the surrounding tissues. The sheath of the arteries contains also their accompanying veins, and sometimes nerves. The coats of the arteries are supplied with blood, like other organs of the body, and the vessels which are distributed to them are named *vasa vasorum*. They are also provided with ganglionic nerves.

### THE PULMONARY ARTERY.

The PULMONARY ARTERY has its origin at the base of the right ventricle, in front of the origin of the aorta. It ascends obliquely to the under surface of the arch of the aorta, where it divides into two branches, one of which passes to the right, the other to the left lung. These divide and subdivide in the structure of the lungs, and terminate in capillary vessels, which form a net-work around the bronchial cells, and become continuous with the minute branches of the pulmonary veins. This artery conveys the impure blood to the lungs,

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How many coats have they? Describe each. Do the arteries terminate directly in veins? What may the entire body of these minute ramifications be considered? How are the arteries separated from the surrounding tissues? What does the sheath contain? What is the name of those vessels which supply the coats of the arteries with blood? Have these coats nerves? *Describe the pulmonary artery.* What is said of its divisions and subdivisions? What establishes the lesser or pulmonic circulation?

and, with its corresponding veins, establishes the *lesser or pulmonic circulation.*

Fig. 143.

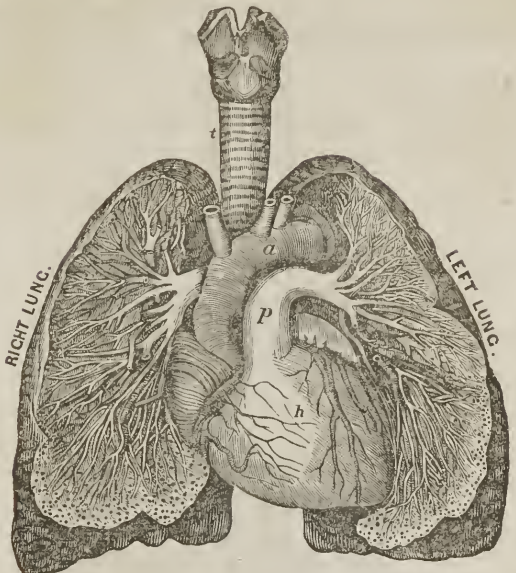


Fig. 143. *t*, Represents the trachea. *h*, The heart. *a*, The aorta. *p*, The pulmonary artery which divides under the arch of the aorta into two branches. These branches divide and subdivide into smaller vessels, which spread through every part of the right and left lung; and they terminate in the capillary vessels of the lungs. The capillary vessels ramify upon the air-cells represented by the small dark points around the margin of the lungs.

## THE AORTA AND ITS BRANCHES.

The AORTA proceeds from the left ventricle of the heart, and contains the pure or arterial blood. This trunk gives off branches, which divide and subdivide to their ultimate ramifications, constituting the great arterial tree which pervades, by its minute subdivisions, every part of the animal frame. This great artery and its divisions, with their returning veins, constitute the *greater or systemic circulation.* The

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What is the design of Fig. 143? *Describe the aorta and its branches.* What constitutes the greater or systemic circulation?

aorta ascends, at first, to the right, then curves backwards to the left, and descends on the left side of the spinal column behind the heart. It is divided into the ascending and descending aorta. In the thorax it is called the thoracic aorta; in the abdomen, the abdominal aorta.

Fig. 144.

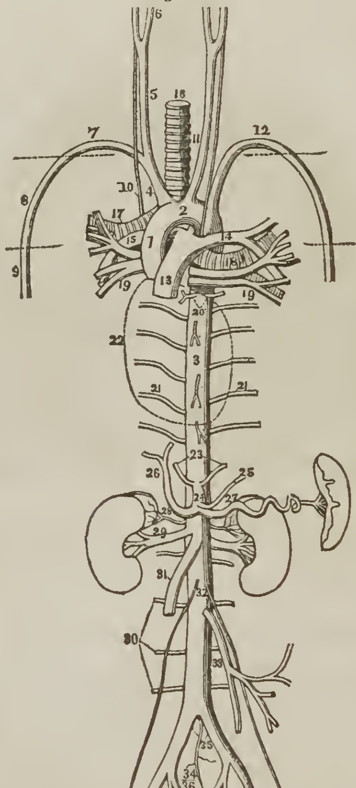

Fig. 144. 16, Represents the trachea. 17, 18, The right and left branch. 1, The ascending aorta 2, The arch of the aorta. 3, The descending aorta. 4, The arteria innominata, dividing into two branches. 5, The right carotid artery. 6, The right internal carotid artery. 7, The right subclavian artery. 8, 9, The brachial artery.

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Describe the course of the aorta. What name is given to it in the thorax? In the abdomen?

10, The pneumogastric nerve. 11, The left carotid artery. 12, The left subclavian artery. 13, The pulmonary artery. 14, 15, The right and left pulmonary artery. 19, 19, The pulmonary veins. 20, 21, 22, The intercostal arteries. 23, The diaphragmatic arteries. 24, The cœliac artery. 25, The gastric artery. 26, The hepatic artery. 27, The splenic artery. 28, The renal artery. 30, The lumbar arteries. 31, The superior mesenteric artery. 32, The spermatic arteries. 33, The inferior mesenteric artery. 35, The division of the aorta into the common iliac artery. 36, The iliac artery.

The arteries 5, 6, and 11, supply the neck and head with blood; 7, 8, 9, and 12, the superior extremities; 13, 14, and 15, the lungs; 20, 21, and 22, the ribs and muscles of the chest; 23, the diaphragm; 25, the stomach; 26, the liver; 27, the spleen; 28, the kidneys; 31 and 33, the intestines; 36, the pelvic organs.

Fig. 145.

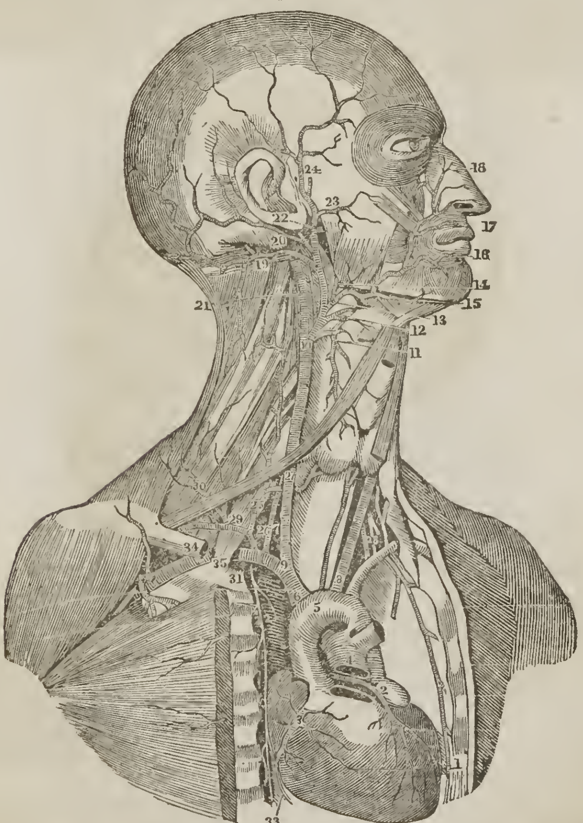


**Fig. 145.** A view of the heart, arch of the aorta, innominata, carotid, and subclavian arteries, &c. The sternum is sawn through, and the thorax is opened on the left side.

1, The heart. 2, The left coronary artery. 3, The right coronary artery. 4, The pulmonary artery, cut through. 5, The arch of the aorta. 6, The arteria innominata. 7, The right primitive carotid artery. 8, The left primitive carotid artery. 9, The division of the innominata into the right primitive carotid and right subclavian arteries. 10, The division of the primitive carotid into external and internal carotid arteries. 11, The superior thyroid artery and its principal branches. 12, The lingual artery. 13, The facial artery. 14, The inferior palatine artery. 15, The submental artery. 16, The inferior coronary artery. 17, The superior coronary artery. 18, One the branches of the nasal artery. 19, The occipital artery. 20. The posterior auricular artery 21, The pharyngeal artery. 22, The division of the external carotid artery into the internal maxillary and superficial temporal 23, The transverse facial artery. 24, One of the anterior auricular branches. 25, The ascending cervical artery. 26, The vertebral artery. 27, The place where the vertebral artery enters the canal of the transverse processes of the vertebræ. 28, The superior intercostal artery. 29, The transverse humeral artery. 30, The transversalis colli artery. 31, The first rib. 32, The anterior mediastinal artery. 33, The superior phrenic artery. 34, The clavicle. 35, The point where the subclavian artery passes over the first rib and under the clavicle.

Fig. 146.

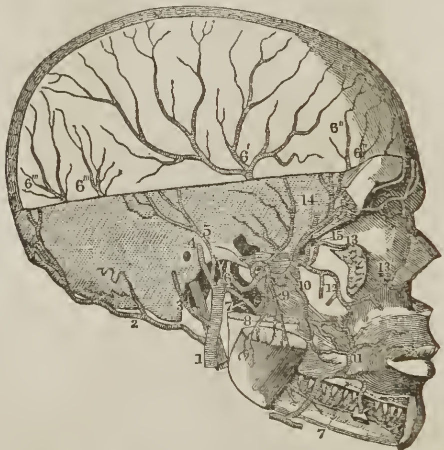


**Fig. 146. A view of the internal maxillary artery.** The right side of the cranium has been removed, all the upper part of the lower jaw, the external table of the rest of the bone, and the outer wall of the orbit.

1, The external carotid artery. 2, The occipital artery and its mastoid branch. 3, The posterior auricular artery, and its stylo-mastoid branch. 4, The superficial temporal and the anterior auricular branches. 5, The middle temporal artery. 6, The internal maxillary artery, which gives off the middle meningeal artery. 6′, The division of the middle meningeal artery. 6″, 6″, The anterior meningeal branches furnished by the ophthalmic artery. 6‴, 6‴, Divisions of the posterior meningeal artery within the cranium. 7, The inferior dental artery. 7, The same artery in the dental canal where it sends branches to the teeth of the lower jaw. 8, The masseteric artery. 9, The pterygoid artery. 10, The buccal artery. 11, The facial artery, anastomosing with the buccal. 12, The alveolar and posterior dental branches. 13, The infra-orbital artery. 13′, The same artery as it appears on the face, passing through the infra-orbital foramen. 14, The deep temporal arteries. 15, The internal maxillary in its passage through the pterygo-maxillary fissure.

The brain is mainly supplied with blood, by the two internal carotids that proceed from the common carotids, and the

What vessels supply the brain with blood?

two vertebral arteries that proceed from the subclavian arteries. The passage of the carotids through the thick bones at the base of the skull, is tortuous, like the letter *S*. The vertebral arteries ascend the neck in channels formed in the transverse processes of the cervical vertebræ, and enter the cavity of the skull at its posterior part, by the side of the spinal cord. The two carotids and two vertebral arteries communicate with each other, and ramify through and supply blood to the brain.

Fig. 147.

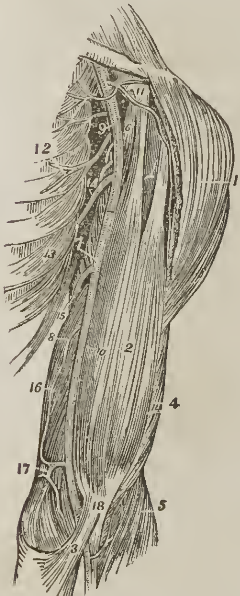

Fig. 148.

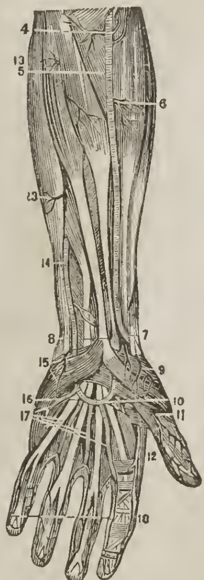

Fig. 147. A representation of the axillary and brachial arteries, with their branches. 1, The deltoid muscle. 2, The biceps. 3, The tendinous process from the tendon of the biceps. 4, The brachialis internus muscle. 5, The supinator longus. 6, The coraco-brachialis. 7, The middle portion of the triceps muscle. 8, Its inner head. 9, The axillary artery. 10, The brachial artery. 11, The acromial artery. 12, The thoracic arteries. 13, The serratus magnus muscle. 14, The subscapular artery. 15, The profunda major artery. 16, The profunda minor artery. 17, The anastomosing artery. 18, The profunda major inosculating with the radial recurrent artery. The arteries 11, 12, 14, 15, 16, 17, and 18, supply the bones, muscles, and skin of the arm, with blood.

Fig. 148. A view of the arteries of the lower portion of the superior extremity 4, The recurrent radial artery. 5, The radial artery. 6, Muscular branches from it. 7, The superficial volar artery. 8, The tendons passing under the annular ligament.

9, A branch of the volar artery on the ball of the thumb. 10, The palmaris profunda artery. 11, The artery of the thumb. 12, The artery of the fore-finger. 13, The muscular arteries of the arm. 14, The lower part of the ulnar artery. 15, Branches to the palm and muscles of the little finger. 16, The superficial arch of the radial and ulnar arteries. 17, Branches running to supply the fingers. 18. The digital arteries that supply the fingers with blood.

Figs. 149, 150, and 151, represent the branches and division of the abdominal aorta, and the ramification of arteries to the liver, stomach, pancreas, spleen, kidneys, and intestines.

Fig. 149.

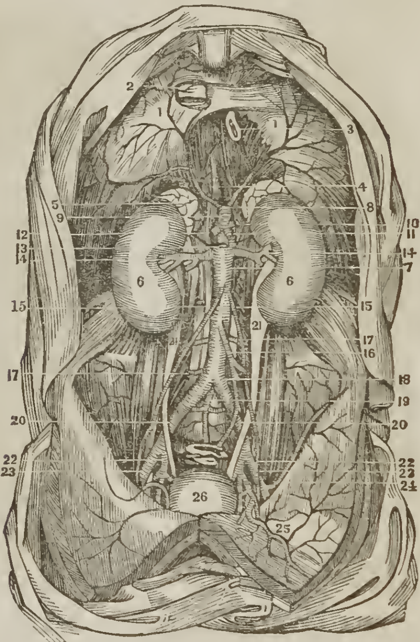


Fig. 149. A view of the abdominal aorta and its branches. 1, 1, The diaphragm. 2, An opening for the ascending vena cava. 3, An opening for the œsophagus. 4, An opening for the aorta, between the crura of the diaphragm. 5, The capsulæ renales. 6, 6, The kidneys. 7, The abdominal aorta. 8, The phrenic arteries. 9, The cœliac artery, that gives off, the splenic artery, (10,) the gastric artery, (11,) and the hepatic artery (12.) 13, Section of the superior mesenteric artery. 14, 14, The emulgent arteries. 15, 15, The spermatic arteries. 16, The inferior mesenteric artery. 17, 17, The lumbar arteries. 18, The division of the abdominal aorta. 19, The middle sacral artery. 20, 20, The primitive iliac arteries. 21, 21, The ureters 22, 22, The internal iliac arteries. 23, 23, The external iliac arteries. 24, The circumflex artery. 25, The distribution of the epigastric artery. 26, The bladder.

Fig. 150.

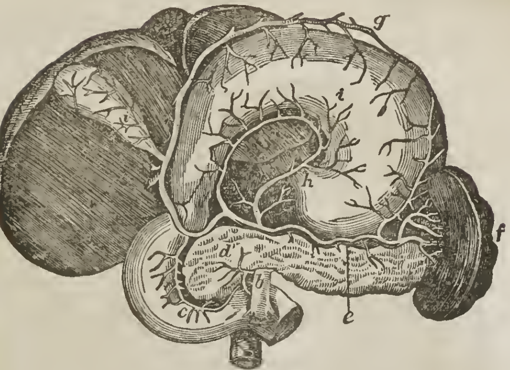


**Fig. 150.** Represents the distribution of the gastric artery upon the stomach. *b*, The superior mesenteric artery. *d*, The pancreas. *f*, The spleen. *g*, The superior coronary artery of the stomach. *h*, The inferior coronary artery; these, with a branch from the splenic artery, (*e*,) supply the stomach with blood. *c*, A branch of the coronary artery that supplies the duodenum with blood. *e*, The cystic artery, that ramifies upon the gall cyst, seen on the under surface of the liver.

From this engraving it will be seen that the stomach, which is one of the most important organs in the animal economy, is supplied with blood, not only from its own coronary arteries, but from the arteries that pass to it from the liver and spleen. A peculiarity of these arteries, is that, though arising from three sources, they inosculate with each other.

In fig. 151, the arteries that pass to the different parts of the intestines, present also the anastomosing arrangement. The same arrangement is strikingly true of the arteries that supply the brain with nutrient blood. The nutrition of the system, the continuance of the digestive functions, the varied offices of the muscles, and the functions of the brain, depend on a continuous flow and also a full supply of blood. Let an artery become obliterated by pressure or disease,—a circumstance by no means infrequent,—and the organs are yet duly supplied with blood, from the inosculating arrangement of the arteries. When a trunk is ligated or rendered impervious to blood, the minute anastomosing arteries, that perform

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Show the design of Fig. 150.

a vicarious office, become enlarged, and consequently the nutrition of the organ is not impaired.

Fig. 151.

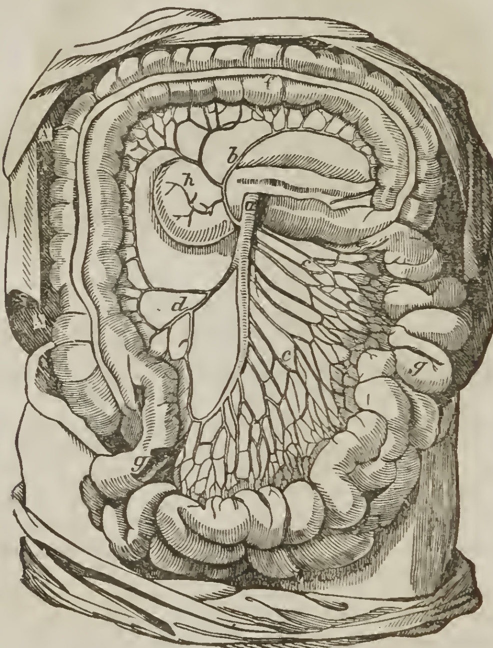


Fig. 151. A, A, The ascending colon. *f*, The transverse colon. *g*, *g*, Represent a portion of the small intestines. *a*, *b*, *c*, *d*, *h*, Represent the superior mesenteric artery and branches, through which the blood that nourishes the large and small intestines passes. The anastomoses, or the connection of arteries, is beautifully represented, and is worthy the attention and remembrance of the student. The inosculation, or hoop-like connection of the arteries, here exhibited, exists in every part of the system.

The following engravings illustrate the course of the principal artery and its branches in the lower limbs.

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What does Fig. 151 represent? What do the two following engravings illustrate?

Fig. 152.

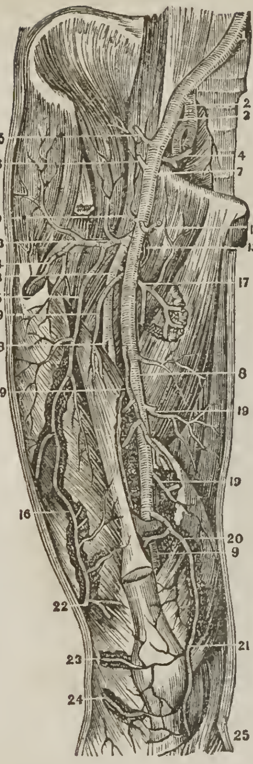

Fig. 153.

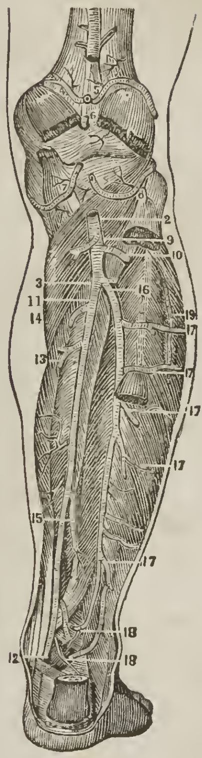

**Fig. 152.** A front view of the iliac and femoral artery. 1, The common iliac. 2, The internal iliac. 3, The external iliac. 4, The epigastric. 5, The circumflex iliac. 6, The cuticular abdominal. 7, The commencement of the femoral, below the crural arch. 8, The point where it passes the vastus internus muscle. 9, The point where it leaves the front of the thigh, to become popliteal. 10, The muscular branch to the psoas muscle. 11, The external pudic artery. 12, The internal circumflex. 13, The profunda femoris. 14, A muscular branch. 15, 16, An artery to the vastus externus muscle. 17, An artery to the pectineus and adductors. 18, The first perforating artery. 19, 19, Muscular arteries. 20, 21, The anastomotica. 22, The superior articular. 23, The middle articular. 24, The inferior external articular. 25, The inferior internal articular.

Fig. 153. A view of the arteries on the back of the leg. 2, The lower end of the popliteal artery on the popliteus muscle. 3, The point of bifurcation into the posterior tibial and peroneal. 4, The superior internal articular artery. 5, The superior exter-

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What do Figs. 152, 153, represent?

nal articular artery. 6, The middle articular artery. 7, The inferior internal articular artery. 8, The inferior external articular artery. 9, Branch to the head of the soleus muscle. 10, The origin of the anterior tibial artery. 11, The origin of the posterior tibial artery. 12, The point where it passes behind the annular ligament to become the plantar. 13, 14, 15, Muscular branches. 16, The origin of the peroneal artery. 17, 17, 17, 17, 17, Muscular branches. 18, 18, Anastomoses of the posterior tibial and peroneal arteries near the heel. 19, Muscular branch from the anterior tibial.

Fig. 154.

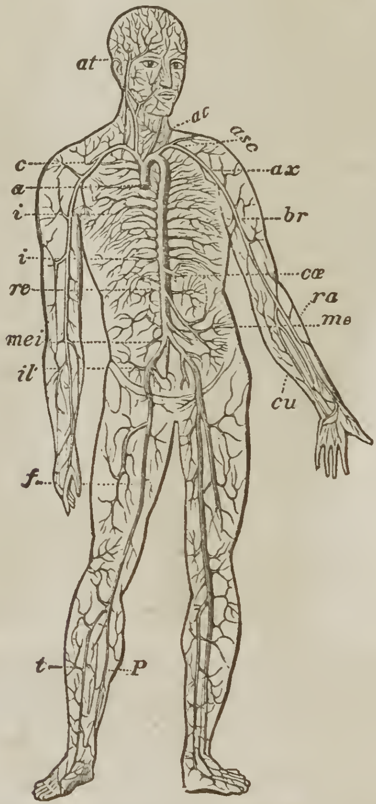


Fig. 154. Represents the aorta and its branches. *a*, The aorta. *c*, Arch of the aorta. *ac*, Carotid arteries. *at*, Temporal arteries. *asc*, Subclavian artery. *ax*, Axillary artery. *br*, Brachial artery. *ra*, Radial artery. *cu*, Cubital or ulnar artery. *i*, *i*, Intercostal arteries. *cœ*, Cœlic artery. *re*, Renal arteries. *me*, *mei*, Superior and inferior mesenteric arteries. *il*, Iliac arteries. *f*, Femoral arteries. *t*, The tibial artery *p*, The peroneal artery.

## ANATOMY OF THE VEINS.

The VEINS are the vessels which return the blood to the auricles of the heart, after it has been circulated by the arteries through the various tissues of the body. They are thinner in structure than the arteries, so that when emptied of their blood they become flattened and collapsed. The veins of the systemic circulation convey the dark-colored and impure or venous blood from the capillary system to the right auricle of the heart. They are found after death more or less distended with that fluid. The veins of the pulmonic circulation resemble the arteries of the systemic circulation, containing, during life, pure or arterial blood, which they transmit from the capillaries of the lungs to the left auricle.

Fig. 155.

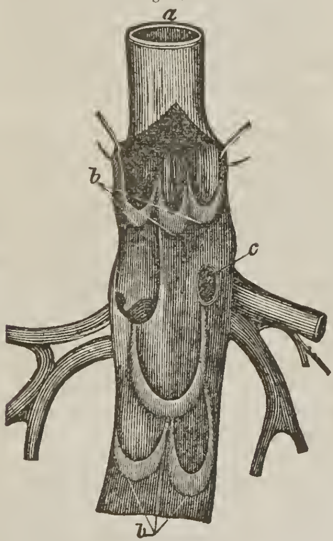


Fig. 155. Represents a vein laid open to show the valves. *a*, Trunk of the vein. *b*, *b*, Valves. *c*, Branch of vein entering it.

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*What office do the veins perform?* How do the veins compare in structure with the arteries? What is their appearance after death? How do the veins of the pulmonic circulation resemble the arteries of the systemic circulation?

The veins commence by minute radicles in the capillaries, which are every where distributed through the textures of the body, and converge to constitute larger and larger branches, till they terminate in the large trunks which convey the venous blood directly to the heart. In diameter they are much larger than the arteries, and like those vessels, their combined area would constitute an imaginary cone, the apex of which is placed at the heart, and the base at the surface of the body. The communications between the veins are more frequent than those of the arteries, and take place between the larger as well as among the smaller vessels. The office of these inosculations is very apparent, as tending to obviate the obstructions to which the veins are peculiarly liable, from the thinness of their coats, and from inability to overcome great impediments by the force of their current.

Veins, like arteries, are supplied with nutrient vessels, (the vasa vasorum ;) and it is to be presumed that nervous filaments from the ganglionic nerves are distributed to their coats.

Veins are composed of three coats, external, middle, and internal.

The external or cellular coat is dense and firm, resembling the cellular tunic of the arteries. The middle coat is fibrous, like that of the arteries, but extremely thin. The internal coat is serous, and also similar to that of the arteries. It is continuous with the lining membrane of the heart at one extremity, and with the lining membrane of the capillaries at the other. At certain intervals, the internal coat forms folds or duplicates, which constitute valves. They are generally composed of two semi-lunar folds, one on each side of the vessel. The free extremity of the valvular folds is concave, and directed forward, so that while the current of blood sets towards the heart, they present no impediment to its free passage ; but let the current become retrograde, and it is impeded by their distension. The valves are most numerous in the veins of the extremities, particularly the deeper veins situated between the muscles ; but in some of the larger trunks, as the vena cavas, and also in some of the smaller veins, no valves exist.

---

Where do the veins commence ? How does their diameter compare with that of the arteries ? What does their combined area constitute ? Where is its apex ? Its base ? What is the apparent design of the inosculation of the veins ? Have the veins nutrient vessels like the arteries ? How many coats have they ? Describe each coat. How are the valves in the veins formed ? What is their use ? Where are they most numerous ?

Fig. 156.


**Fig. 156.** A side view of the superficial arteries and veins of the face and neck. 1, The external jugular vein. 2, The anastomosing branch of the cephalic vein of the arm to the external jugular. 3, The external jugular vein. 4, Communications of the external and internal jugular vein. 5, 5, The occipital vein and branches. 6, The occipital artery. 7, The posterior auricular artery and vein. 8, The point where the external jugular is formed by the union of the temporal and internal maxillary veins. 9, The temporal artery and vein. 10, The frontal branches of the same. 11, The internal jugular vein. 12, The superior thyroid artery and vein. 13, The lingual artery and vein. 14, The facial artery. 15, The point of union between the nasal and facial artery. 16, The facial vein separated from the artery except at its origin and termination. 17, The inferior coronary artery and vein. 18, The superior coronary artery and vein. 19, The ascending nasal vein. 20, The nasal branches of the ophthalmic artery and vein. 21, The frontal vein.

The veins of the exterior of the head, as the facial, internal maxillary, temporal, posterior auricular, and occipital, unite with the veins from the brain, and form the two internal and external jugular veins that are seen represented upon the

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How are the internal and external jugular veins formed?

neck. These veins unite with the large veins from the upper extremities.

Fig. 157.

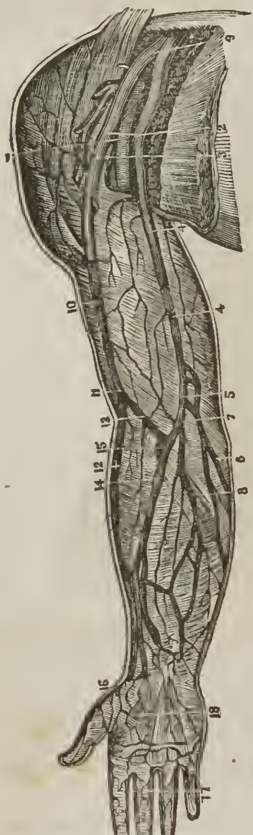

Fig. 158.

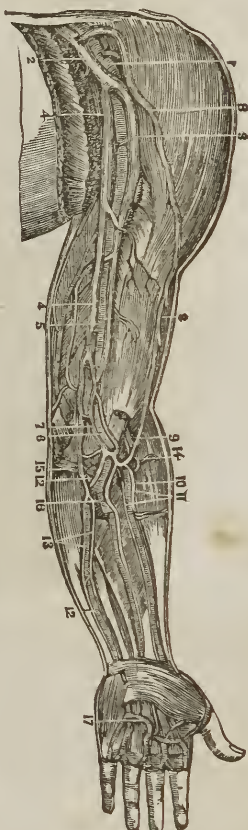

Fig. 157. The superficial veins on the front of the upper extremity. 1, The axillary artery. 2, The axillary vein. 3, The basilic vein. 4, 4, A portion of the basilic vein. 5, The point where the median basilic joins the basilic vein. 6, Points to the posterior basilic vein. 7, The median basilic vein. 8, The anterior basilic vein. 9, The point where the cephalic enters the axillary vein. 10, A portion of the same vein, as seen under the fascia. 11, The point where the median cephalic enters the cephalic vein. 12, The lower portion of the cephalic vein. 13, The median cephalic vein. 14, The median vein. 15. An anastomosing branch of the deep and superficial veins of the arm.

16, The cephalica-pollicis vein. 17, The subcutaneous veins of the fingers. 18, The subcutaneous palmar veins.

Fig. 158. The deep-seated veins on the front of the upper extremity, in their relation to the arteries. 1, The axillary artery. 2, The axillary vein. 3, The humeral vein. 4, The basilic vein. 5, The brachial artery. 6, The same artery at the bend of the arm. 7, The median basilic vein. 8, 8, The cephalic vein. 9, The median cephalic vein. 10, The radial artery. 11, Its two attending veins. 12, 12, The ulnar artery. 13, Its two attending veins. 14, The recurrent radial artery and vein. 15, The recurrent ulnar artery and vein. 16, The interosseal arteries and veins. 17, The palmar arch and vessels of the fingers.

The upper extremities have both the deep-seated and superficial veins. The deep-seated veins accompany the branches and trunks of the arteries, and constitute their venæ comites. The superficial veins upon the fore-arm are named the anterior and posterior radial and ulnar. These unite at the elbow to form the median basilic and cephalic veins. These veins unite and form in the arm the cephalic and basilic veins. These, with the deep-seated veins unite and form the axillary and subclavian veins. The right and left subclavian, with the jugular veins of the right and left side, form the vena cava, descending.

The veins of the lower extremities are deep-seated and superficial. The deep-seated veins accompany the arteries in pairs, and form the venæ comites of the anterior and posterior tibial and peroneal arteries. These veins unite at the bend of the knee, termed the popliteal region, and form a single vein of large size, named the popliteal. This vein becomes the femoral in the thigh, and the iliac at the lower part of the abdomen. It receives the external and internal saphena veins. The latter is frequently seen dilated on the inner side of the limb, forming the varicose veins. The two iliac veins unite to form the vena cava, ascending.

The veins of the trunk may be divided as follows, namely: 1. The superior vena cava, with its formative branches. 2. The inferior vena cava, with its formative branches. 3. The azygos vein. 4. The vertebral and spinal veins. 5. The cardiac veins. 6. The portal veins. 7. The pulmonary veins. The vertebral and spinal veins convey the blood from the spinal cord and column. The cardiac veins receive the blood from the heart. The portal veins receive the blood from the spleen and intestines, and convey it to the liver; while the pulmonary veins transfer the blood from the lungs to the left side of the heart.

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How are the subclavian veins formed? How is the popliteal vein formed? How are the veins of the trunk divided?

Fig. 159.

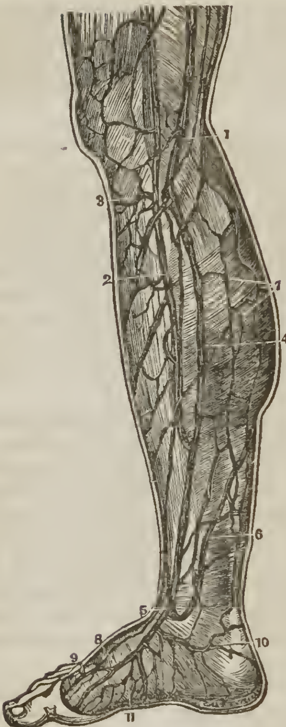


Fig. 160.

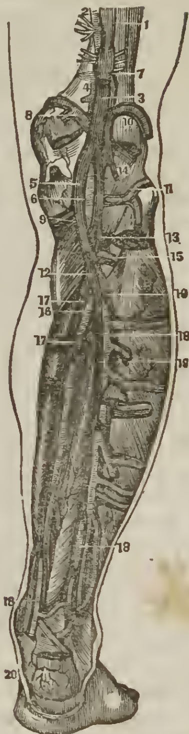


Fig. 159. The superficial veins on the inner side of the legs. 1, The saphena major at the inside of the knee. 2, A collateral branch of the saphena major on the leg. 3, The anastomosis of the veins below the knee. 4, The internal saphena at the middle of the calf of the leg. 5, The origin of the saphena vein at the ankle joint. 6, The anastomosing branch of the saphena major and minor. 7, Branches on the back of the leg. 8, The great internal vein of the foot. 9, The arch of veins on the metatarsal bone. 10, A branch from the heel. 11, Branches on the sole of the foot.

Fig. 160. The arteries and deep seated veins on the back of the leg. 1, The popliteal vein. 2, The popliteal artery. 3, 4, A vein and artery in their relative positions on the back of the knee joint. 5. The popliteal vein on the inner side of the joint. 6, The popliteal artery without and beneath it. 7, The extremity of the saphena minor vein. 8, 9, The internal articular vessels to both arteries and veins. 10, 11, The external articular vessels, both arteries and veins. 12, The junction of the peroneal and posterior tibial veins. 13, A venous branch from the anterior tibial vein. 14, A vein from the gastrocnemius. 15, The anterior tibial artery coming through the interosseous ligament. 16, The posterior tibial artery. 17, Its two attending veins. 18, The peroneal artery. 19, Its two attending veins. 20, The vessels on the heel.

Fig. 161.

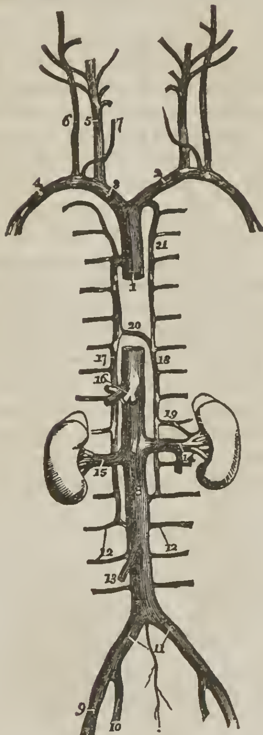


Fig. 161. The veins of the trunk and neck. 1, The superior vena cava. 2, The left vena innominata. 3, The right vena innominata. 4, The right subclavian vein. 5, The internal jugular vein. 6, The external jugular. 7, The anterior jugular. 8, The inferior vena cava. 9, The external iliac vein. 10, The internal iliac vein. 11. The common iliac veins; the small vein between which is the vena sacra media. 12, 12, The lumbar vein. 13, The right spermatic vein. 14, The left spermatic, opening into the left renal vein. 15, The right renal vein. 16, The trunk of the hepatic veins. 17, The greater vena azygos, commencing inferiorly in the lumbar veins. 18, The lesser vena azygos, also commencing in the lumbar veins. 19, A branch of communication with the left renal vein. 20, The termination of the lesser in the greater vena azygos. 21, The superior intercostal vein, communicating inferiorly with the lesser vena azygos, and terminating superiorly in the left vena innominata.

Every medium-sized artery is accompanied by two veins; this, in connection with the greater diameter of the veins over their accompanying arteries, makes the capacity of the venous system superior to that of the arterial system. The greater capacity of the venous system counterbalances the difference of velocity of the circulating fluid in the arterial system. When the forces of the circulatory system are diminished, there is an accumulation of blood in the large veins, which is called congestion.

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What does Fig. 161 represent?

## ANATOMY OF THE CAPILLARY VESSELS.

The CAPILLARIES constitute a microscopic net-work, which is so distributed through every part of the body as to render it impossible to introduce the smallest needle beneath the skin without wounding several of these fine vessels. It is through the medium of the capillaries that the operations of nutrition and secretion are performed. They are remarkable for the uniformity of diameter, and for the constant divisions and communications which take place between them. They inosculate on the one hand with the terminal extremity of the arteries, and on the other with the commencement of the veins. They are the connecting link between the arteries and veins. The important operation of converting the nutrient materials of the blood into bone, muscle, &c., is performed in this part of the circulatory system. The particular manner in which this is effected has been a matter of discussion among physiologists. When the matter deposited by these vessels exceeds that removed by the absorbents, the individual increases in size. The inosculation of the capillaries, and their relation to the arterial and venous vessels, are illustrated in the following engraving.

Fig. 162.

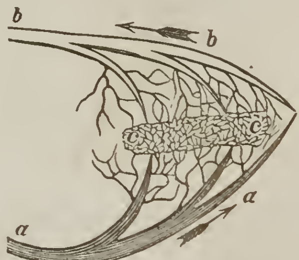


Fig. 162. *a, a,* An artery dividing into several branches that terminate in capillaries. *c, c, b, b,* A venous trunk formed from several small veins that commence in the capillaries.

The double circulation of the blood through the heart will be easily comprehended by carefully examining the following

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*Describe the capillary vessels.* What peculiar operations are performed in these vessels? For what are they remarkable? Describe Fig. 162. How many pulmonary veins convey the blood from the lungs to the left auricle of the heart? How is the blood then conveyed to every part of the system?

engraving. It would aid the student to examine the preceding engravings, representing the different parts of the heart.

Fig. 163.

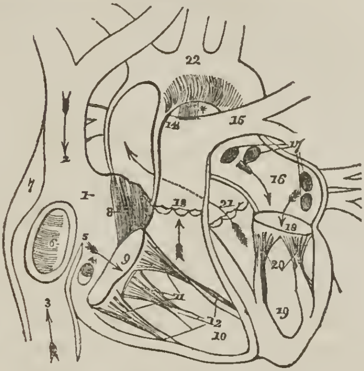


Fig. 163. 1, The right auricle of the heart. 2, The entrance of the superior vena cava. 3, The entrance of the inferior vena cava. 4, The opening of the coronary vein, half closed by the coronary valve. 5, The Eustachian valve. 6, The fossa ovalis, surrounded by the annulus ovalis 7, The tuberculum Loweri. 8, The musculi pectinati in the appendix auriculæ. 9, The opening of the right auricle into the right ventricle. 10, The cavity of the right ventricle. 11, The tricuspid valves, attached by the chordæ tendineæ to the carneæ columnæ, (12.) 13, The pulmonary artery, guarded at its commencement by three semi-lunar valves. 14, The right pulmonary artery, passing beneath the arch, and behind the ascending aorta. 15, The left pulmonary artery, crossing in front of the descending aorta. *, The remains of the ductus arteriosus, acting as a ligament between the pulmonary artery and the arch of the aorta. The arrows mark the course of the venous blood through the right side of the heart. Entering the auricle by the superior and inferior cavæ, it passes through the opening of the auricle into the ventricle, and thence through the pulmonary artery into the lungs. 16, The left auricle. 17, The openings of the four pulmonary veins. 18, The opening of the left auricle into the left ventricle. 19, The left ventricle. 20, The mitral valves, attached by their chordæ tendineæ to two large columnæ carneæ, which project from the walls of the ventricle. 21, The commencement and course of the ascending aorta behind the pulmonary artery, marked by an arrow. The entrance of the vessel is guarded by three semi-lunar valves. 22, The arch of the aorta. The comparative thickness of the two ventricles is shown in the diagram. The course of the pure blood through the left side of the heart is marked by arrows. The blood is brought from the lungs by the four pulmonary veins into the left auricle, and passes through the opening between the auricle and ventricle into the left ventricle, whence it is conveyed by the aorta to every part of the body.

## PHYSIOLOGY OF THE HEART.

The walls of all the cavities of the heart are composed of muscular fibres, which are endowed with the property of contracting and relaxing, like other parts of the muscular system. The contraction and relaxation of the muscular tissue of the

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What does Fig. 163 exhibit? *Give the physiology of the heart.* Of what are the walls of the cavities of the heart composed? What operations take place at every pulsation of the heart?

heart, produce a diminution and enlargement of both auricular and ventricular cavities. These occur at every pulsation or beat of the heart.

The venous blood is poured from the ascending and descending cavas, (2, 3, Fig. 163,) into the right auricle, 1. When the right auricle contracts, the blood received from the cavas is forced through the opening, 9, into the ventricle, 10. When the right ventricle contracts, the right auricle dilates. At this moment, the tricuspid valves, 11, close the opening between the auricle and ventricle, and prevent the blood from reflowing into the auricle. The blood in the ventricle is pressed by ventricular contraction into the pulmonary artery at 13. As soon as the ventricle has ejected the blood in its cavity into the artery, it dilates, and receives another amount of blood from the auricle. When the ventricle expands, the three semi-lunar valves, 13, close the orifice at the commencement of the pulmonary artery. This prevents the reflux of blood from the artery into the ventricle. The tricuspid valves will permit the blood to pass from the auricle into the ventricle, and the semi-lunar valves will also allow the blood to move from the ventricle into the artery, while both sets prevent a retrograde movement of the sanguineous fluid.

The blood in the pulmonary artery is distributed through the lungs, where it is purified, and returned through the pulmonary veins to the left auricle of the heart, 16. Then it is forced by the contraction of the muscular walls of the auricle, through the opening, 18, into the ventricular cavity, 19. The auricle then dilates to receive a fresh supply of blood from the pulmonary veins, while the ventricle contracts, and forces the blood lodged in its cavity, into the aorta, 21. When the ventricle contracts, the mitral valves, 20, close the orifice between the auricle and ventricle, which prevents the reflow of blood into the auricle. When the ventricle dilates to receive another quantity of blood from the auricle, the semi-lunar valves of the aorta, 21, close the opening of this artery, and prevent the blood from flowing from the artery into the ventricle. Thus we see that the mitral valves permit the blood to pass from the auricle into the ventricle, and the semi-lunar

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Into which auricle do the cavas pour their contents? Illustrate the circulation from the right auricle. Through what vessel is the venous blood carried to the lungs? How returned to the heart? From what source does the left auricle receive blood? Illustrate the circulation from the left auricle. The left ventricle.

valves likewise permit the blood to flow from the ventricle into the aorta, while both prevent its retrograde movement. If these valves are injured, or destroyed, the circulation will be as much disordered as the movements of a fire engine, or pump, by the destruction of its valves. Some of the most serious diseases of the heart, consist in a partial or complete destruction of these valves.

The right and left auricles contract simultaneously. When these contract, the right and left ventricles dilate. The dilatation of the ventricles is termed the *diastole* of the heart; their contraction, its *systole*.

Let the pupil draw a diagram of the heart upon the black board, and from it explain the double circulation of the blood through it.

## PHYSIOLOGY OF THE ARTERIES, VEINS, AND CAPILLARIES.

The blood is carried to and from the heart by the agency of the *arteries*, *veins*, and *capillaries*. These vessels are found in every tissue of the system. They are necessary to the proper distribution of the blood. The relations of these vessels and the heart will be easily comprehended by attention to diagram 164.

The venous blood is carried from the right ventricle of the heart, *c*, through the pulmonary artery, *d*, *d*, to the air cells in the lungs, x, x. Over the walls of these vesicles, the pulmonary capillary vessels ramify. The blood is purified in passing through the *capillaries* from the pulmonary artery to the pulmonary vein, *e*, *e*, through which it is returned to the left auricle of the heart, *f*. From the left auricle the blood is carried to the left ventricle, *g*. From the left ventricle it is forced into the aorta, A. Through the branches of the aorta, *h*, *h*, and *i*, *i*, the purified blood is carried to every organ in the system. These arteries terminate in capillaries, 1, 1, 1, 1. Through these minute capillaries, the blood is conveyed to the radicles of the veins. In the capillaries the blood loses its vermilion color, and becomes of a dark modena hue. From the capillaries the blood is returned to the right auricle of the heart, *b*, through the veins, *a*, *a*, *a*, *a*.

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Through what agency is the blood carried to and from the heart? Describe the circulation of the venous blood in the heart and lungs. At what point is the blood purified? What is the relative position of the arteries and veins?

Let the student make a diagram upon the black board, of the *pulmonic* arteries and veins, and the *systemic* arteries and veins, with the relative positions of the air cells and capillary vessels; and from the diagram trace the pulmonic and systemic circulations.

Fig. 164.

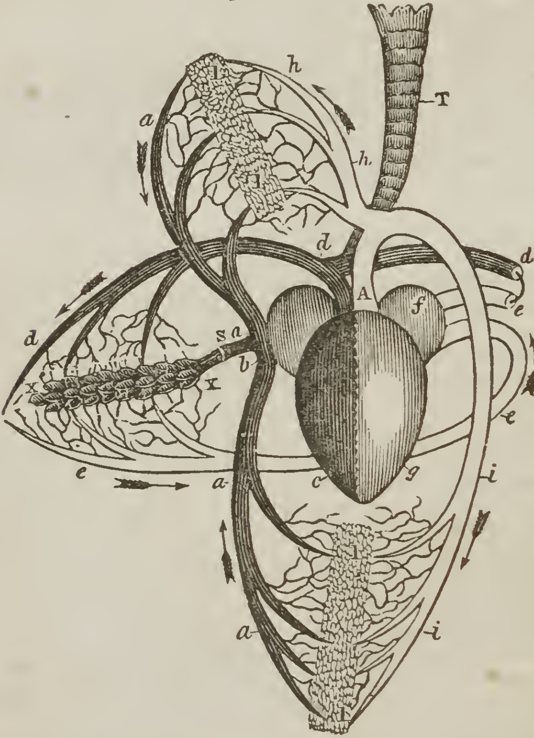


Fig. 164. *T*, The trachea. *S*, A bronchial tube. x, x. Air vesicles, in which the bronchi terminate. *a*, *a*, *a*, *a*, Systemic veins, through which the impure blood is returned to the right auricle. *b*, The right auricle. *c*, The right ventricle. *d*, *d*, *d*, The right and left pulmonary arteries. *e*, *e*, *e*, The pulmonary veins. *f*, The left auricle. *g*, The left ventricle. A, The aorta. *h*, *h*, *i*, *i*, Branches of the aorta, through which the blood is carried to the system. 1, 1, 1, 1, Capillary vessels, in which the small arteries terminate, and in which the veins commence.

The blood is carried from the heart in the arteries; 1st, by

How is the blood first impelled from the heart to the arteries?

the contraction of the muscular walls of the heart. The energy of the contraction of the heart varies in different individuals. It is likewise modified by the health and tone of the system. It is difficult to estimate the muscular power of the heart; but, comparing it with other muscles, and judging from the force with which blood is ejected from a severed artery, it must be very great. 2nd. The contractile and elastic middle coat of the arteries renders important aid to the heart in impelling the blood to the minute vessels of the system. 3d. The peculiar action of the minute capillary vessels, is considered by some physiologists to be of much importance as a motive power in the arterial circulation.

The blood is returned to the heart through the veins by the contraction of the venous coat, and the *vis a tergo*, or propulsive power of the heart, arteries, and capillary vessels. This is shown by the immediate arrestment of the blood which follows, when these forces are suspended. There are concurrent causes which are supposed to have some influence upon the venous circulation. One is the suction power attributed to the heart, acting as a *vis a fronte*, in drawing blood towards it. Another important agency has been found by some physiologists, in the inspiratory movements, which are supposed to draw the blood of the veins in the chest, in order to supply the vacuum which is created there by the elevation of the ribs and the descent of the diaphragm.

One of the most powerful causes which influence the venous circulation, is the frequently-recurring action of the muscles upon the venous trunks. When the muscles are contracted, they compress that portion of the veins which lie beneath their contracted bellies, and thus force the blood from one valve to the other, towards the heart. When they are relaxed, the veins refill, and are compressed by the recurring action of the muscles.

The muscles exercise an agency, in maintaining the venous circulation at a point above what the heart could perform. As the pulsations are diminished by rest, so they are accelerated by exercise, and very much quickened by violent effort.

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Does the contractile energy of the heart vary? How do the arteries aid the heart in impelling the blood through the system? How is the venous blood returned to the heart? What are the concurrent causes which are supposed to influence the venous circulation? What is one of the most powerful causes that influence the venous circulation? Describe the action of the muscles upon the veins, in impelling the venous blood.

There can be little doubt that the increased rapidity of the return of blood through the veins, is of itself a sufficient cause for the accelerated movements of the heart, during active exercise. When a large number of muscles are called into action after repose, as when we rise from a recumbent or sitting posture, the blood is driven to the heart with a very strong impetus. If that organ should be diseased, it may arrive there in a larger quantity than can be disposed of, and death may be the result. Hence the necessity for the avoidance of all sudden and violent movements, on the part of those who have either a functional or structural disease of the heart.

## THE BLOOD.

The blood is composed of two parts; a watery fluid, called *serum;* and a solid portion, called the *coagulum*, or *clot*. The coagulum contains concreted *albumen;* a white substance which forms on the upper surface, called *fibrine;* and red globulated matter which is found on its lower surface. The color of the red globules is owing to the presence of iron, though some physiologists think it depends on an animal substance of a gelatinous character.

The blood is not necessarily red. It may be white, as in the fish; transparent, as in the insect; or yellowish, as in the reptile. There is no animal in which the blood is red in all parts of the body. The ligaments and tendons in man, are not supplied with red, but with white blood.

Ordinarily, a complete revolution of the blood is effected every *three minutes*. The ventricles contract, or the *pulse beats*, seventy-five times in a minute in an adult, one hundred and forty in an infant, and in old age about sixty. The blood constitutes about one fifth part of the weight of the whole body. As about two ounces are expelled at each contraction of the ventricles, thirty-five pounds, on an average, must pass through the heart every three minutes, seven hundred pounds

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What rule is given for those who may have a disease of the heart? Why this precaution? *Of how many parts is the blood composed?* How is the coagulum formed? Of what color is the blood of the fish? The insect? The reptile? What part of the human system has white blood? How often is there a complete revolution of the circulating fluid? How many pulsations in a minute in an adult? In an infant? In the aged? How many ounces of blood are expelled at each contraction of the ventricles? How much every hour?

every hour, and sixteen thousand pounds, or *eight tons*, every twenty-four hours.

## PRACTICAL SUGGESTIONS.

1. If any part of the system be deprived of blood, its vitality will cease; but if the blood be diminished in quantity to a limited extent, only the vigor and health of the part will be impaired. 2. If the constituent elements of the blood be changed, or, in other words, if the blood becomes impure, the functional action of the different organs of the system will be deranged, and active disease may be induced.

The following conditions, if observed, would favor the free and regular supply of blood to all parts of the system:

1st. Wear the clothing loosely on *every part of the system*, as compression of any kind impedes the passage of blood through the vessels of the compressed part. The observance of this condition is particularly important in respect to the chest, as this cavity contains the lungs, heart, large arteries, and veins.

The blood which passes to and from the brain, traverses the vessels of the neck. If the dressing of this part be close, the circulation will be impeded, and the functions of the brain will be impaired. This remark is particularly important to scholars, public speakers, individuals predisposed to apoplexy and other diseases of the brain.

As many of the large veins lie immediately beneath the skin, through which the blood is returned from the lower extremities, if the ligatures used to retain the hose, or any other article of apparel, in proper position, should be tight and inelastic, the passage of blood through these vessels would be obstructed, producing, by their distension, the varicose or enlarged veins. Hence, *elastic* bands should always be used for these purposes.

2d. The temperature of all parts of the system should be as equal as possible, as a chill on one portion of the body

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How much every twenty-four hours? What is the effect if any part of the system be deprived of blood? If the blood be diminished in quantity? What is the effect upon the system when the blood becomes impure? Why should the clothing on every part of the system be loosely worn? To whom is the tight dressing of the neck particularly injurious? Why? Why should the temperature of every part of the system be nearly equal?

diminishes the size of its blood-vessels, and the blood which should distend and stimulate the chilled part, will accumulate in other organs. The deficiency of blood in the chilled portion induces weakness, while the superabundance of sanguineous fluid may cause disease in another part of the system.

The skin should be kept not only of an equal temperature, but the warmth of it should be so maintained, by adequate clothing, that no chill shall produce a contraction of the circulating vessels and a consequent paleness. If the skin be not kept warm, the blood will recede from the surface of the body, and accumulate in the internal organs. Cleanliness of the skin and clothing is likewise demanded, for the reason, that this condition favors the free action of the cutaneous vessels.

3d. The action of the muscles is one of the important forces which impel the blood through the arteries and veins. Hence, daily and regular exercise of the muscular system, is required, to sustain a vigorous circulation in the extremities and skin, and also to maintain a healthy condition of the system. The best stimulants to improve the sluggish circulation of an indolent patient, whose skin is pale and whose extremities are cold, are the union of vigorous muscular exercise with agreeable mental action, and the systematic application to the skin, of cold water, attended with friction in bathing.

4th. When a considerable number of muscles are called into energetic action, a greater quantity of blood will be propelled to the lungs and heart in a given time, than when the muscles are in a state of comparative inaction. The flow of blood to the lungs and large veins, before the range and frequency of the movements of the respiratory organs are increased, in a degree corresponding to the accumulation of blood in the lungs, is attended by a painful sensation of fullness, and oppression in the chest, with violent and irregular action of the heart.

This condition of the organs within the cavity of the chest, called congestion, may be followed by cough, inflammation of the lungs, asthma, and the structural disease of the heart. To avoid such sensations and results, when we feel necessitated to walk or run a considerable distance in a short time, com-

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What effect will be produced if the skin be not kept warm? Why should the muscular system be regularly exercised? What are the best stimulants for sluggish circulation in indolent persons? How may congestion of the lungs be produced?

mence the movements in a moderate manner, increasing the speed as the respiratory movements become more frequent and their range more extensive, so that a sufficient amount of air may be received into the lungs to purify the increased quantity of blood forced upon them. The same principles should be observed when commencing labor, and in driving horses and other animals.

2. To maintain the blood of the system in a state of purity, requires attention to the practical suggestions upon the skin, muscles, digestion, and lungs. (*See these different sections.*)

If the blood has become "impure," or "loaded with humors," (an idea generally prevalent,) it is not and cannot be "purified," by taking, "*ad libitum*," patent pills, powders and drops. The blood may become impure by retention of the waste product, which should have been eliminated from the system by the agency of the cutaneous vessels, which have become inactive. This inactivity may be produced by improper and inadequate clothing, or by a want of cleanliness, as explained in the chapter on the skin. The only successful method to be pursued for the purifying of the blood and the restoration of health in this case, is to observe the directions given relative to clothing and bathing, in Chap. II.

The blood may be made impure, by the chyle being deficient in quantity, or defective in quality. This state of the chyle may be produced by the food being improper in quantity or quality, or by its being taken in an improper manner, at an improper time, and when the system is not prepared for it. The remedy for impure blood produced in any of these ways is to correct the injudicious method of using food, by observing the suggestions in Chap. VI.

Again, the blood may be rendered impure, by not supplying it with oxygen in the lungs, and by the carbon not being eliminated from the system through this channel. The remedy for "impurities of the blood," produced in this manner, would be, to carefully reduce to practice the directions under the head of "practical suggestions," in the chapter on the respiratory organs, relative to the free movements of the ribs and diaphragm, and the proper ventilation of rooms.

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What advice is given when we are necessitated to walk or run a considerable distance in a short space of time? Will patent pills and powders purify the blood if the cutaneous vessels are inactive? Give some of the remedies for impurity of the blood.

# CHAPTER X.

## THE NERVOUS SYSTEM.

THE nervous system consists of a central organ, the cerebro-spinal axis or centre, and of numerous rounded and flattened white cords, called nerves, which are connected at one extremity, with the cerebro-spinal centre, and at the other, distributed to all the textures of the body. The sympathetic system is an exception to this description; for, instead of one, it has many small centres, which are called ganglia, and which communicate very freely with the cerebro-spinal axis, and with its nerves.

The cerebro-spinal axis consists of two portions — the *brain*, and the *spinal cord*. For convenience of description, the nervous system may be divided into — 1, the brain; 2, the cranial nerves; 3, the spinal cord; 4, the spinal nerves; 5, the sympathetic nerve.

### ANATOMY OF THE BRAIN.

The term BRAIN designates those parts of the nervous system, exclusive of the nerves themselves, which are contained within the cranium, or skull bones; they are the *cerebrum*, *cerebellum*, and *medulla oblongata*. These are invested and protected by the membranes of the brain. The whole together constitute the *encephalon*, from the Greek, *eg*, in, and *kephale*, head.

The membranes of the brain are the *dura mater*, *arachnoid*, and *pia mater*.

The DURA MATER is a firm, fibrous membrane, which is exposed on the removal of a section of the skull bones. This lines the interior of the skull and spinal column, and likewise sends processes inward, for the support and protection of the

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Of what does the nervous system consist? What constitutes an exception to this? How is the nervous system divided? *Describe the brain.* How many membranes has it? Describe the dura mater. What is its use?

different parts of the brain. It also sends processes externally, which form the sheaths for the nerves, as they quit the skull and spinal column. The dura mater is supplied with arteries and nerves.

The ARACHNOID, or spider's web membrane, so named from its extreme tenuity, is the serous membrane of the brain and spinal cord, and, is, like other serous membranes, a shut sac. It envelopes these organs and is reflected upon the inner surface of the dura mater, giving to that membrane its serous investment. There are no vessels in the arachnoid, and no nerves have been traced into it.

Fig. 165.

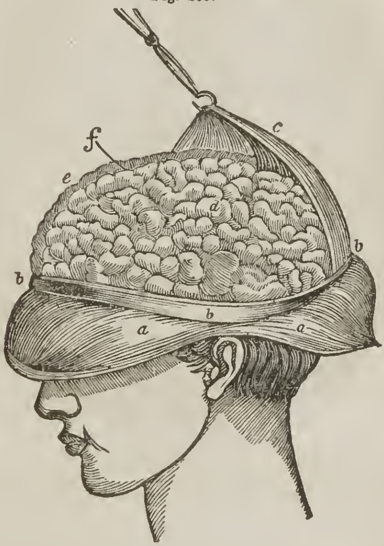


Fig. 165. *a, a,* Represents the scalp turned down. *b, b, b,* The cut edge of the bones of the skull. *c,* The external strong membrane of the brain, the dura mater, suspended by a hook. *d,* The left hemisphere of the brain, showing its convolutions. *e,* The superior edge of the right hemisphere. *f,* The fissure between the two hemispheres.

The PIA MATER is a vascular membrane, composed of

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Describe the arachnoid membrane. What is one of its uses? Describe the pia mater.

innumerable vessels, held together by cellular membrane. It invests the whole surface of the brain, and dips into its convolutions. The pia mater is the nutrient membrane of the brain, and receives its blood from the carotid and vertebral arteries. Its nerves are minute branches of the sympathetic, which accompany the branches of the arteries.

Fig. 166.

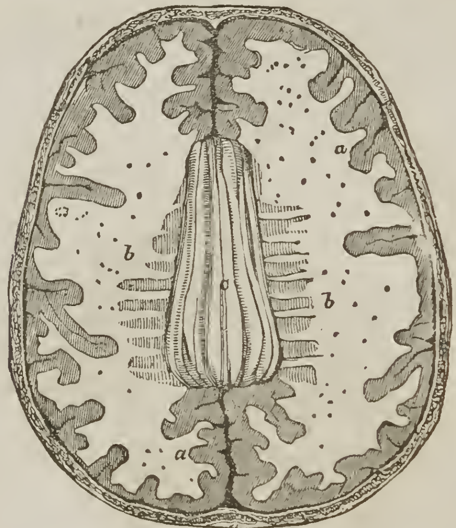


Fig. 166, Represents a horizontal section of the bones of the skull and brain. *a*, *a*, The outer layer, of ash-colored matter. *b*, *b*, The white, medullary, central part of brain. *c*, The corpus callosum. The dots in the white portion indicate the situation of the divided arteries.

### THE CEREBRUM.

The CEREBRUM is divided into two hemispheres, by a cleft, or fissure. Into this cleft dips a portion of the dura mater, named the *falx cerebri*, from its resembling a sickle. The

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Which membrane nourishes the brain? How is the cerebrum divided? What is the use of the falx cerebri?

design of this membrane seems to be to relieve the one side from the pressure of the other, when the head is reclining to either side. Upon the superior surface of the cerebrum, are seen undulating windings, named convolutions. Upon its inferior surface, each hemisphere admits of a division into three lobes — the anterior, middle, and posterior.

Fig. 167.

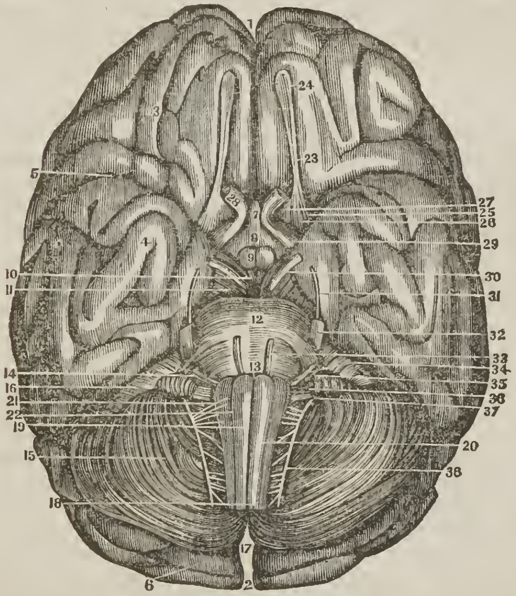


Fig. 167, Represents the base of the cerebrum and cerebellum, together with their nerves. 1, The anterior extremity of the fissure of the hemispheres of the brain. 2, The posterior extremity of the same fissure. 3, The anterior lobe of the cerebrum. 4, Its middle lobe. 5, The fissure that separates the anterior and middle lobes. 6, The posterior lobe of the cerebrum. 7, The point of the infundibulum. 8, Its body. 9, The corpora albicantia. 10, Cineritious matter. 11, The crura cerebri. 12, The pons varolii. 13, The top of the medulla oblongata. 14, The posterior prolongation of the pons varolii. 15, The middle of the cerebellum. 16, The anterior part of the cerebellum. 17, Its posterior part and the fissure of its hemispheres. 18, The superior part of the spinal cord. 19, The middle fissure of the medulla oblongata. 20, The corpus pyramidale. 21, The corpus restiforme. 22, The corpus olivare. 23, The olfactory nerve. 24, Its bulb. 25, Its external root. 26, Its middle root. 27, Its internal root. 28, The optic nerve beyond the chiasm or crossing. 29, The optic nerve before the chiasm. 30, The third pair of nerves. 31, The fourth pair. 32, The fifth pair. 33, The sixth pair. 34, The facial nerve. 35, The auditory nerve. 36, 37, 38, The eighth pair of nerves.

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What is seen upon the superior surface of the brain? Its inferior?

If the upper part of the hemispheres be removed horizontally with a sharp knife, a centre of white substance will be observed. This is surrounded by a border of gray, which follows the depressions of the convolutions, and presents a zigzag outline. The divided surface will be seen to be studded with numerous small, red points, which are produced by the escape of blood from the divided ends of the minute arteries and veins. The gray border is named the cortical, or cineritious portion. The *corpus callosum* is a dense layer of transverse fibres, connecting the two hemispheres.

## THE CEREBELLUM.

The CEREBELLUM is about seven times smaller than the cerebrum. Like that organ it is composed of white and gray matter, but the gray constitutes the largest portion. Its surface is formed of parallel plates separated by fissures. The white matter is so arranged, that when cut vertically, the appearance of the trunk and branches of a tree is presented. Hence it is named *arbor vitæ*. It is situated under the posterior lobe of the cerebrum, from which it is separated by a process of the dura mater, named the *tentorium*. (See Figs. 167, 168.)

The MEDULLA OBLONGATA, or that portion of the spinal cord which is within the skull, consists of three pairs of bodies united in a single bulb, namely, the *corpora pyramidalia*, *corpora olivaria*, and *corpora restiformia*. (See 13, 20, 21, 22, Fig. 167.)

The brain is of a pulpy character, quite soft in infancy and childhood; but it gradually becomes more and more consistent, and in middle age it assumes the form of determinate structure and arrangement. It is more abundantly supplied with blood than any organ of the system. No absorbents have been detected in this organ.

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Describe the appearance of the brain when a horizontal section has been made. What is the gray border often called? What connects the hemispheres? How does the cerebellum compare in size with the cerebrum? What is its appearance when cut vertically? Where is the cerebellum or little brain situated? Describe the medulla oblongata. What is the character of the brain in childhood? In adults? Have absorbent vessels been detected in this organ?

## PHYSIOLOGY OF THE BRAIN.

The brain is regarded, by physiologists and philosophers, as the organ of the mind. Most writers consider it as an aggregate of parts, each charged with specific functions, and that these functions are the highest and most important in the animal economy. To the large brain, or cerebral lobes, they ascribe the seat of the faculties of *thinking*, *memory*, and *the will.* To the cerebellum, or little brain, the seat of the *animal* or *lower propensities.*

The constant relation between mental power and development of brain, explains why capacities and dispositions are so different, and shows incontrovertibly, that the cultivation of the moral and intellectual faculties can be successfully carried on only by acting in obedience to the laws of organization, and associating together those faculties the organs of which are simultaneously progressive in that growth. In infancy, for example, the intellectual powers are feeble and inactive. This arises solely from the inaptitude of a still imperfect brain ; but in proportion as the latter advances towards its mature state, the mental faculties also become vigorous and active.

The brain likewise holds an important relation to all the other organs of the system. To the muscular system it imparts an influence which induces contraction of the fibres. By this relation they are brought under the control of the will. The digestive, respiratory, and circulatory apparatus is enabled to perform its functions by the influence imparted to it by the cerebral organ of the nervous system.

## PRACTICAL SUGGESTIONS.

As the different organs of the system are dependent on the brain and spinal cord, for efficient functional action, and as the mind and brain are closely associated during life, the former acting in strict obedience to the laws which regulate the latter, it becomes an object of primary importance in education, to

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*How is the brain regarded by physiologists and philosophers?* What do they ascribe to the cerebrum ? To the cerebellum ? What does the relation between mental powers and development of brain explain ? If the mind and brain be closely associated, what becomes an object of primary importance in education ?

discover what these laws are, that we may yield them willing obedience, and escape the numerous evils consequent on their violation.

"As the brain is subject to the same general laws as other organs of the system, we say that a sound, original constitution is the FIRST condition of its healthy action. If the brain from birth be free from all hereditary taints and imperfections, and has acquired no unusual susceptibility from injudicious treatment in infancy, it will resist a great deal in after life, before its health will yield. But if, on the other hand, it has inherited deficiencies, or early mismanagement has subsequently detailed upon it an unusual proneness to morbid action, it will yield under circumstances which would otherwise have been perfectly harmless. Accordingly, it may truly be said, that the most powerful of all causes which *predispose* to nervous and mental disease, is the transmission of a *hereditary* tendency from parents to children, producing in the latter an unusual liability to the maladies under which the parents have labored.

Even where the defect in the parent is merely some peculiarity of disposition or temper, amounting, perhaps, to eccentricity, it is astonishing how clearly its influence on some one or other of the progeny, may often be traced, and how completely a constitutional bias of this description may interfere with a man's happiness or success in life. We have seen instances in which it pervaded every member of a family, and others in which it affected only one or two. When the original eccentricity is on the mother's side, and she is gifted with much force of character, the evil extends more widely among the children, than when it is on the father's side. Where both parents are descended from tainted families, the progeny is, of course, more deeply affected, than where one of them is from a pure stock. Seemingly for this reason, hereditary predisposition is a more usual cause of nervous disease in the higher classes, who intermarry much with each other, than in the lower, who have a wider choice.

Unhappily, it is not merely as a cause of disease, that he-

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What is the *first* condition of the healthy action of the brain? Why? Illustrate this. In what case of minor importance may this hereditary influence be evinced? If the defect be on the side of the mother? The effect if both parents have the same hereditary taints? What is one cause of nervous diseases among the higher classes?

reditary predisposition is to be dreaded. The obstacles which it throws in the way of permanent recovery, are even more formidable, and can never be entirely removed. Safety is to be found only in avoiding the perpetuation of the mischief. Therefore, if two persons, each naturally of excitable and delicate nervous temperament, choose to unite for life, they have themselves to blame for the concentrated influence of similar tendencies in destroying the health of their offspring, and subjecting them to all the miseries of nervous disease, madness, or melancholy. *The command of God not to marry within certain degrees of consanguinity, is in accordance with the organic laws of the brain, and the wisdom of the prohibition is confirmed by correct observation.*

The SECOND condition required for the health of the brain, is a due supply of properly oxygenated blood. The effects of slight differences in the quality of the blood, are not easily recognized, but, when they exist in an extreme degree, the effects are too obvious to be overlooked. If the stimulus of arterial blood be altogether withdrawn, the brain ceases to act, and sensibility and consciousness become extinct. Thus, when fixed air is inhaled, the blood circulating through the lungs does not undergo that process of oxygenation which is essential to life. As it is in this state unfit to excite or support the action of the brain, the mental functions become impaired, and death closes the scene. If, on the other hand, the blood be too highly oxygenated, — as by breathing oxygen gas instead of common air, the brain is too much stimulated, and an intensity of action, bordering on inflammation, takes place, which also soon terminates in death.

Such are the consequences of the two extremes; but the slighter variations in the state of the blood, have equally sure, though less palpable effects. If its vitality be impaired by breathing an atmosphere so much vitiated as to be insufficient to produce the proper degree of oxygenation, the blood then affords an imperfect stimulus to the brain. As a necessary consequence, languor and inactivity of the mental and nervous functions ensue, and a tendency to headache, fainting,

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Why is hereditary predisposition to be dreaded? What is the *second* condition required for the health of the brain? What effects arise from differences in the quality of the blood? Give another instance of the injurious effects of impure blood. What effects are produced by slighter variations in the quality of the blood?

or hysteria, makes its appearance. This is every day seen in the listlessness and apathy prevalent in *crowded and ill-ventilated school-rooms ; and in the headaches and liability to fainting, which are so sure to attack persons of a delicate habit, in the contaminating atmospheres of crowded theatres, churches, and assemblies.* It is less strikingly, but more permanently exhibited, in the irritable and sensitive condition of the inmates of cotton manufactories and public hospitals. In these instances, the operation of the principle cannot be disputed; for the languor and nervous debility consequent on confinement in ill-ventilated apartments, or in air vitiated by the breath of many people, are neither more nor less than minor degrees of the same process of poisoning, to which we have formerly alluded. *(See Physiology of Digestion and Respiration.)* It is not real debility which produces them; for egress to the open air almost instantly restores activity to both mind and body, unless the exposure has been very long, in which case, more or less time is required to reëstablish the exhausted powers of the brain. A good deal of observation has convinced us, that the transmission of imperfectly oxygenated blood to the brain, is much more influential in the production of *nervous disease*, and in delicacy of constitution, than is commonly imagined.

The THIRD condition of health in the brain and nervous system, is, the regular exercise of their respective functions.

The brain, being an organized part, is subject, so far as regards exercise, to the same laws as the other organs of the body. If it be doomed to inactivity, its health will decay, and the mental operations and feelings, as a necessary consequence, will become dull, feeble, and slow. If it be duly exercised, after regular intervals of repose, the mind will acquire readiness and strength. Lastly, if it be overtasked, either in the force or the duration of its activity, its functions will become impaired, and irritability and disease will take the place of health and vigor.

The consequences of *inadequate* exercise will first be explained. We have seen that by disuse the muscles become

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Mention instances where this is commonly evinced. Why is the operation of the principle in these instances indisputable? Show why real debility is not the cause. What is the *third* condition of health in the brain and nervous system? What is the effect if the brain be not duly exercised? If it be duly exercised? If it be overtasked?

emaciated, the bones soften, and the blood vessels are obliterated. The brain is no exception to this general rule. It is impaired by permanent inactivity, and becomes less fit to manifest the mental powers with readiness and energy. Nor will this surprise any reflecting person, who considers that the brain, as a part of the same animal system, is nourished by the same blood, and regulated by the same vital laws, as the muscles, bones, and arteries.

It is the weakening and depressing effect which is induced by the absence of the stimulus necessary for the healthy exercise of the brain, that renders solitary confinement so severe a punishment, even to the most daring minds. Keeping the above principle in view, we shall not be surprised to find, that *non-exercise* of the brain and nervous system, or, in other words, inactivity of intellect and feeling, is a very frequent predisposing cause of every form of nervous disease. For demonstrative evidence of this position, we have only to look at the numerous victims to be found among females of the middle and higher ranks, who have no calls to exertion in gaining the means of subsistence, and no objects of interest on which to exercise their mental faculties, and who, consequently, sink into a state of mental sloth and nervousness, which not only deprives them of much enjoyment, but subjects them to suffering, both of body and mind, from the slightest causes.

But let the situation of such persons be changed; bring them, for instance, from the listlessness of retirement, to the business and bustle of the city; give them a variety of imperative employments, and so place them in society as to supply to their cerebral organs that extent of exercise which gives health and vivacity of action, and in a few months, the change produced will be surprising. Health, animation, and energy, will take the place of former insipidity and dullness. An additional illustration, involving an important principle in the production of many distressing forms of disease, will be found in the case of a man of mature age, and of active hab-

What is the consequence of disuse of the organs mentioned in preceding chapters? Does the same principle apply to the brain? Why? What renders solitary confinement so severe a punishment to the most daring minds? What is a predisposing cause of nervous disease? In what classes do mental and nervous debility prevail? How can this be counteracted? Give another illustration showing how disease of the brain is induced.

its, who has devoted his life to the toils of business, and whose hours of leisure have been few and short. Suppose such a person to retire to the country, in search of repose, and to have no moral, religious, or philosophical pursuits to occupy his attention, and keep up the active exercise of his brain, — this organ will lose its health, and the inevitable result will be, weariness of life, despondency, or some other variety of nervous disease.

One great evil attending the absence of some imperative employment, or object of interest, to exercise the mind and brain, is the tendency which it generates to waste the mental energies on every trifling occurrence which presents itself, and to seek relief in the momentary excitement of any sensation, however unworthy. The best remedy for these evils, is to create occupation to interest the mind, and give that wholesome exercise to the brain, which its constitution requires.

The evils arising from *excessive* or ill-timed exercise of the brain, or any of its parts, are numerous, and equally at variance with the ordinary laws of physiology. When we use the eye too long, or in too bright a light, it becomes blood-shot. The increased action of its vessels and nerves, gives rise to a sensation of fatigue and pain, requiring us to desist. If we relieve the eye, the irritation gradually subsides, and the healthy state returns. But, if we continue to look intently, or resume our employment before the eye has regained its natural state by repose, the irritation at last becomes permanent, and disease, followed by weakness of vision, or even blindness, may ensue.

Phenomena precisely analogous occur, when, from intense mental excitement, the brain is kept long in a state of excessive activity. The only difference is, that we can always see what happens in the eye, but rarely what takes place in the brain; occasionally, however, cases of fracture of the skull occur, in which, part of the bone being removed, we can see the quickened circulation in the vessels of the brain as easily as those of the eye. Sir Astley Cooper had a young man brought to him, who had lost a portion of his skull, just above

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What is one great evil attending the absence of some imperative employment to exercise the mind and brain? What is the true remedy for these evils? From what other cause do evils arise to the brain? Explain the evil of it by the excessive use of the eye. What is the only difference in the analogy of the phenomena of the eye and brain? Has the analogy been verified?

the eyebrow. "On examining the head," says Sir Astley, "I distinctly saw that the pulsation of the brain was regular and slow; but at this time he was agitated by some opposition to his wishes, and directly the blood was sent with increased force to the brain, and the pulsation became frequent and violent." Indeed, in many instances, the increased circulation in the brain, attendant on high mental excitement, reveals itself when least expected, and leaves traces after death, which are very perceptible. When tasked beyond its strength, the eye becomes insensible to light, and no longer conveys any impressions to the mind. In like manner, the brain, when much exhausted, becomes incapable of thought, and consciousness is almost lost in a feeling of utter confusion.

At any time of life, excessive and continued mental exertion is hurtful; but in infancy and early youth, when the structure of the brain is still immature and delicate, permanent mischief is more easily produced by injudicious treatment than at any subsequent period. In this respect, the analogy is as complete between the brain and the other parts of the body, as that exemplified in the injurious effects of premature exercise of the bones and muscles. Scrofulous and rickety children are the most usual sufferers in this way. They are generally remarkable for large heads, great precocity of understanding, and small, delicate bodies. But in such instances, the great size of the brain and the acuteness of the mind, are the results of morbid growth. Even with the best of management, the child passes the first years of its life constantly on the brink of active disease. Instead, however, of trying to repress its mental activity, the fond parents, misled by the early promise of genius, too often excite it still farther, by unceasing cultivation, and the never-failing stimulus of praise. Finding its progress for a time equal to their warmest wishes, they look forward with ecstasy to the day when its talents will break forth and shed lustre on its name. But in exact proportion as the picture becomes brighter to their fancy, the probability of its being realized becomes less; for the brain, worn out by premature exertion, either becomes diseased or loses its tone, leaving the mental powers imbecile and depressed for the

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Relate the case detailed by Sir Astley Cooper. Is excessive and continued mental exertion hurtful at any age? At what age particularly so? What is said of scrofulous and rickety children? What is the cause of their early promise and their subsequent disappointment?

remainder of life. The expected prodigy is thus easily outstripped in the social race by many whose dull outset promised him an easy victory.

Taking for our guide the necessities of the constitution, it will be obvious that the modes of treatment commonly resorted to ought to be reversed. Instead of straining to the utmost the already irritable powers of the precocious child, and leaving his dull competitor to ripen at leisure, a systematic attempt ought to be made, from early infancy, to rouse to action the languid faculties of the latter, while no pains ought to be spared to moderate and give tone to the activity of the former. Instead of this, however, the prematurely intelligent child is sent to school and tasked with lessons at an unusually early age, while the healthy but more backward boy, who requires to be stimulated, is kept at home in idleness, perhaps for two or three years longer, merely on account of his backwardness. A double error is here committed. The consequences to the intelligent boy are, frequently, the permanent loss both of health and of his envied superiority of intellect.

In youth, too, much mischief is done by the long, daily period of attendance at school, and the continued application of the mind which the ordinary system of education requires. The law of exercise, that long-sustained action exhausts the vital powers of the organ, applies as well to the brain as to the muscles. Hence, the necessity of varying the occupations of the young, and allowing frequent intervals of exercise in the open air, instead of enforcing the continued confinement now so common.

In early and middle life, fever, with an unusual degree of cerebral disorder, is a common consequence of the excessive and continued excitement of the brain. This unhappy result is brought on by severe study, unremitted mental exertion, anxiety, and watching. Nervous disease, from excessive mental labor and exaltation of feeling, sometimes shows itself in another form. From the want of proper intervals of rest, the vascular excitement of the brain, which always accompa-

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What mode of treatment should be adopted? How should the dull or less active child be treated? What is the usual course? What is the consequence of the error? What error prevails in the present system of education? Why should youths be allowed frequent intervals to exercise in the open air? What is a frequent consequence of continued and excessive excitement of the brain? Under what form do nervous diseases sometimes manifest themselves, from excessive mental labor?

nies activity of the mind, has not time to subside. A restless irritability of temper and disposition comes on, attended with sleeplessness and anxiety, for which no external cause can be assigned. The symptoms gradually become aggravated, the digestive functions give way, nutrition is impaired, and a sense of wretchedness is constantly present, which often leads to attempts at suicide.

Having pointed out the evils arising both from inadequate and from excessive mental exertion, it remains to direct the attention to some of the rules which should guide us in the exercise of the brain.

1st. It seems to be a law of the animal economy, that when two classes of functions are called into vigorous action at the same time, one or both will, sooner or later, sustain injury. Hence, the important rule never to enter upon continued mental exertion, or to arouse deep feeling, immediately after a full meal, as the activity of the brain is sure to interfere with that of the stomach, and disorder its functions. Even in a perfectly healthy person, unwelcome news, sudden anxiety, or mental excitement, occurring soon after eating, will impede digestion, and cause the stomach to loathe the masticated food. In accordance with this rule, we learn by experience that the worst forms of indigestion and nervous depression are those which arise from excessive application of mind, or turmoil of feeling, conjoined with unrestrained indulgence in the pleasures of the table. In such circumstances, the stomach and brain react upon and disturb each other, till all the horrors of nervous disease make their unwelcome appearance, and render life miserable. Literary men and students know this fact from sad experience.

2d. The time best adapted for mental exertion is next to be considered. Nature has allotted the darkness of the night for repose, and for the restoration by sleep of the exhausted energies of mind and body. If study or composition be ardently engaged in towards that period of the day, the increased action of the brain, which always accompanies activity of mind, requires a long time to subside. If the individual be at all of an irritable habit of body, he will be sleepless for hours

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What is a law of the animal economy? What rule is here given? How are the worst forms of indigestion and nervous depression produced? What class of men experience this fact? What evils arise from studious applica tion at night?

after he has retired, or perhaps be tormented by unpleasant dreams. It is, therefore, of great advantage to engage in severe studies early in the day, and to devote several of the hours which precede bedtime, to lighter reading, music, or conversation. The vascular excitement previously induced in the head by study, has then time to subside, and sound, refreshing sleep is much more certainly obtained. This rule is of great consequence to those who are obliged to undergo much mental labor.

3d. *Periodicity*, or a tendency to resume the same mode of action at stated times, is peculiarly the characteristic of the nervous system. On this account, regularity is of great consequence in exercising the moral and intellectual powers. If we repeat any kind of mental effort every day at the same hour, we at last find ourselves entering upon it without premeditation when the time approaches. In like manner, if we arrange our studies in accordance with this law, and take up each in the same order, a natural aptitude is soon produced, which renders application more easy than by resuming the subjects as accident may direct.

4th. The necessity of judicious repetition in mental and moral education is, in fact, too little adverted to, because the principle which renders it efficacious has not been understood. To induce facility of action in the organs of the mind, practice is as essential as it is in the organs of motion.

In physical education, we are aware of the advantages of repetition. We know, that if practice in dancing, fencing, skating, and riding, is persevered in, for a length of time sufficient to give the muscles the requisite promptitude and harmony of action, the power will be ever afterwards retained, although little called into use; whereas, if the muscles have not been duly trained, we may reiterate practice at different intervals, without proportionate advancement. The same principle applies equally to the moral and intellectual powers, because these operate by means of material organs.

Repetition is thus necessary to make a durable impression on the brain. According to this principle, it follows, that in

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When should the student pursue the abstruse, and when the lighter studies? For what reason? What is another characteristic of the nervous system? What is the tendency of this? What is rarely adverted to in mental education? Why? How is it with physical education? Why is repetition necessary in mental efforts?

learning a language or science, six successive months of application will be more effectual in fixing it in the mind and making it a part of its furniture, than double or treble the time, if the lessons are interrupted by long intervals. Hence, it is a great error to begin and study, and then break off, to finish at a later period. The fatigue is thus doubled, and the success greatly diminished. The best way is to begin at the proper age, and to persevere till the end is attained. This accustoms the mind to sound exertion, and not to *fits* of attention. Hence, the evil arising from long vacations; and hence the evil of beginning studies before the age at which they can be understood, as in teaching the abstract rules of grammar to children; to succeed in which, implies in them a power of thinking, and an amount of general knowledge, which they do not possess.

## CRANIAL NERVES.

There are nine pairs of cranial nerves. Taken in their order, from before, backwards, they are, — 1, Olfactory. 2, Optic. 3, Motores oculorum. 4, Patheticus. 5, Trifacial. 6, Abducentes. 7, Facial (portio dura), auditory (portio mollis.) 8, Glosso-pharyngeal. Pneumo-gastric, (vagus, par. vagum.) Spinal accessory. 9, Hypo-glossal (lingual.)

The origin of these nerves, at the base of the brain and commencement of the spinal cord, is seen in Figs. 167, 168.

These nerves are functionally or physiologically divided into four groups, and in this order we shall examine them.

1. *Nerves of Special Sense.* — 1st, Olfactory; 2d, optic; 7th, auditory.

2. *Motion.* — 3d, Motores oculorum; 6th, abducentes; 9th, hypo-glossal.

3. *Respiration.* — 4th, Patheticus; 7th, facial; 8th, glosso-pharyngeal, pneumogastric and spinal accessory.

4. *Spinal.* — 5th, Trifacial.

## NERVES OF SPECIAL SENSE.

1st pair, *Olfactory.* This nerve passes through the cribriform plate of the ethmoid bones, and ramifies on the mem-

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What is said of learning a language or science? *How many pairs of cranial nerves are there?* Repeat their names. Into how many groups are these nerves divided, functionally and physiologically? What are they called? Give the names of each division.

brane that covers the vomer and turbinated bones of the nose. (*See Sense of Smell.*)

2d pair, *Optic.* This nerve pierces and is spread out on the back part of the orbit of the eye. (*See Sense of Vision.*)

7th pair, *Auditory*, (portio mollis.) This nerve enters the petrous portion of the temporal bone, at the internal auditory opening, and is distributed to the internal ear. (*See Sense of Hearing.*)

Fig. 168.


Fig. 168. Represents a vertical section of the cerebrum, cerebellum, and medulla oblongata, showing the relation of the cranial nerves at their origin. 1, The cerebrum. 2, The cerebellum, with its arbor vitæ represented. 3, The medulla oblongata. 4, The spinal cord. 5, The corpus callosum. 6, The first pair of nerves. 7, The second. 8, The eye. 9, The third pair of nerves. 10, The fourth pair. 11, The fifth pair. 12, The sixth pair. 13, 14, The seventh pair. 15, 16, 17, The eighth pair. 18, The ninth pair. 19, The spinal accessory nerve. 20, Spinal nerves. 21, The membrane that separates the cerebrum from the cerebellum.

## NERVES OF MOTION.

3d pair, *Motores oculorum.* This nerve ramifies on the muscles of the eye.

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Describe the course of the olfactory nerve. The optic nerve. The auditory.

6th pair, *Abducentes.* This nerve is appropriated to the external straight muscle of the eye.

9th pair, *Hypo-glossal* (lingual.) This is the true motor nerve of the tongue, and ramifies upon the lingual muscles. This nerve communicates with the pneumogastric, spinal accessory, first and second cervical nerves, and the sympathetic nerve.

Fig. 169.


Fig. 169. Represents the distribution of the third, fourth, and sixth pairs of nerves, to the muscles of the eye. 1, The ball of the eye and rectus externus muscle. 2, The upper jaw. 3, The third pair, distributed to all the muscles of the eye, except the superior oblique and external rectus. 4, The fourth pair, going to the superior oblique muscle. 5, One of the branches of the seventh pair. 6, The sixth pair, distributed to the external rectus. 7, The spheno-palatine ganglion and branches. 8, The ciliary nerves from the lenticular ganglion.

## ANATOMY OF THE RESPIRATORY NERVES.

Sir Charles Bell groups under this head certain nerves which are associated in the movements of respiration. They all arise in the course of a distinct tract, situated between the corpus olivare and corpus restiforme, on each side of the medulla oblongata. Hence, this portion of the brain has been named the respiratory tract.

For the origin of the respiratory nerves, see Fig. 171 and its explanation.

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Describe the sixth and ninth pairs of nerves. Explain Fig. 169. What nerves did Sir Charles Bell call the respiratory? Describe their origin.

The first of these nerves is the 4th pair, *patheticus* (trochlearis.) This is distributed upon the superior oblique or trochlearis muscle.

The second of these nerves is the 7th pair, *facial* (portio dura.) This nerve passes from the cranium, through the stylo-mastoid foramen, below the ear. It is distributed over the side of the face, supplying the muscles.

Fig. 170.


**Fig. 170**, Represents the distribution of the facial nerves, and some of the branches of the cervical plexus of nerves. 1, The facial nerve, escaping from the stylo-mastoid foramen. 2, The posterior auricular branch. 3, The temporal branch. 4, The frontal nerve. 5, Facial branches. 6, The infra-orbital nerve. 7, Facial branches. 8, The mental nerve. 9, Branches to the face and neck. 10, The superficialis colli nerve, forming a plexus (11) over the submaxiliary gland. 12, 13, 14, 15 and 16, Nerves that have their origin in the cervical portion of the spinal cord. They are distributed to the muscles and skin of the neck and back of the head. The nerves 1, 2, 3, 5, 7, and 9, are branches of the seventh pair, and are distributed over the face in a radiated direction, which constitutes the pes anserinus. The nerves 4, 6, 8, are branches of the fifth pair. The branches of the fifth, seventh and cervical nerves communicate with each other.

The third of these nerves is the 8th pair. This pair consists of three nerves; the *glosso-pharyngeal*, *pneumogastric*, and *spinal accessory*.

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What is the fourth pair of nerves called, which issues from the brain? The seventh pair? Where distributed? The eighth pair? Into how many branches is this pair divided?

Fig. 171.

Fig. 171, Represents the distribution of the respiratory nerves. *a*, Section of the brain and medulla oblongata. *b*, The lateral columns of the spinal cord. *c*, *c*, The spinal cord. *d*, The tongue. *e*, The larnyx. *f*, The bronchi. 6, The œsophagus. *h*, The stomach. *i*, The diaphragm. 1, The pneumogastric nerve. 2, The superior laryngeal nerve. 3, The recurrent laryngeal nerve. These two ramify on the larynx. 4, The pulmonary plexus of the eighth nerve. 5, The cardiac plexus of the eighth nerve. These two plexuses supply the heart and lungs with nervous filaments. 7, The origin of the fourth pair of nerves, that goes to the superior oblique muscle of the eye. 8, The origin of the facial nerve, that is spread out on the side of the face and nose. 9, The origin of the glosso-pharyngeal nerve, that goes to the tongue and pharynx. 10, The origin of the spinal accessory nerve of Willis. 11, This nerve penetrating the sterno-mastoideus muscle. 12, The origin of the internal respiratory or phrenic nerve, that is seen to ramify on the diaphragm. 13, The origin of the external respiratory nerve, that ramifies on the pectoral and scaleni muscles. Let the pupil, from this graphic engraving, explain the distribution of the respiratory nerves.

The *Glosso-pharyngeal* nerve is distributed to the mucous membrane of the side and base of the tongue and throat, and also to the mucous glands of the mouth, and to the tonsils.

The *Pneumogastric* nerve (vagus) sends branches to the larynx, pharynx, œsophagus, lungs, spleen, pancreas, liver, stomach, and intestines. It communicates with the glosso-pharyngeal, spinal accessory, hypo-glossal, and sympathetic.

The *Spinal Accessory* nerve passes through the sterno-mastoideus muscle, to which it sends branches, and also to the trapezius muscle.

The *Phrenic* nerve passes from the lateral column of the spinal cord, and is distributed to the diaphragm.

The *External Respiratory* nerves pass with the phrenic nerve from the same tract of matter in the spinal cord. They are distributed to the intercostal muscles that lie between the ribs, and to the muscles that connect the ribs with the shoulder.

### PHYSIOLOGY OF THE RESPIRATORY NERVES.

It is through the instrumentality of the accessory, phrenic, and external respiratory nerves, that the muscles employed in respiration are brought into action, without the necessity of the interference of the mind. Though to a certain extent they may be under the influence of the will, yet it is only in a secondary degree. No one can long suspend the movements of respiration; for in a short time instinctive feeling issues its irresistible mandate, which neither requires the aid

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Where is the glosso-pharyngeal distributed? The pneumogastric? With what does this nerve communicate? Where does the spinal accessory nerve pass? The phrenic nerve? Describe the external respiratory nerves. Through the agency of what nerves are the respiratory muscles brought into action? Can respiration be suspended for any considerable length of time?

of erring wisdom, nor brooks the capricious interference of the will.

The fourth, seventh, and eighth pairs of nerves, with the spinal accessory, phrenic, and external respiratory, are not only connected with the function of respiration, but contribute to the expression of the passions and emotions of the mind.

The influence of this order of nerves in the expression of the passions, is strikingly depicted in Sir Charles Bell's Treatise on the Nervous System. "In terror," he remarks, "we can readily conceive why a man stands with his eyes intently fixed on the object of his fears — the eye-brows elevated, and the eye-balls largely uncovered; or why, with hesitating and bewildered steps, his eyes are rapidly and wildly in search of something. In this way, we only perceive the intense application of his mind to the objects of his apprehension, and its direct influence on the outward organs. But when we observe him further, there is a spasm in his breast; he cannot breathe freely; the chest remains elevated, and his respiration is short and rapid. There is a gasping and convulsive motion of his lips, a tremor on his hollow cheeks, a gasping and catching of his throat; his heart knocks at his ribs, while yet there is no force in the circulation; the lips and cheeks being ashy pale.

"These nerves are the instruments of expression, from the smile upon the infant's cheek, to the last agony of life. It is when the strong man is subdued by this mysterious influence of soul on body, and when the passions may be truly said to tear the heart, that we have the most afflicting picture of human frailty, and the most unequivocal proof that it is the order of functions we have been considering, that is thus affected. In the first struggle of the infant to draw breath, in the man recovering from a state of suffocation, and in the agony of passion, when the breast labors from the influence at the heart, the same system of parts is affected, the same nerves, the same muscles, and the symptoms or character have a strict resemblance."

The facial nerve not only communicates the purposes of the will to the muscles of the face, but at the same time, it

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What does Sir Charles Bell say of the influence of this order of nerves in the expression of the passions? Are they also the instruments of expression, either of joy or grief?

calls them into action, under the influence of instinct and sympathy. On this subject a late writer remarks, "how expressive is the face of man! How clearly it announces the thoughts and sentiments of the mind! How well depicted are the passions on his countenance! tumultuous rage, abject fear, devoted love, envy, hatred, grief, and every other emotion, in all their shades and diversities, are imprinted there in characters so clear that he that runs may read! How difficult, nay, how impossible, is it to hide or falsify the expressions which indicate the internal feelings! Thus conscious guilt shrinks from detection, innocence declares its confidence, and hope anticipates with bright expectation."

## ANATOMY OF THE TRIFACIAL NERVE.

The fifth pair of nerves, sometimes called the *trigemini*, is analogous to the spinal nerves in its origin by two roots, from the anterior and posterior columns of the spinal cord, and in the existence of a ganglion on the posterior root, called the casserion. Hence it ranges with the spinal nerves, and is considered the cranial spinal nerve.

This nerve divides into three branches, the *opthalmic*, *superior maxillary*, and *inferior maxillary* nerve.

The *opthalmic* branch sends a branch to the forehead, called the *frontal;* another branch to the eye, called the *lachrymal;* and a third branch to the nose, called the *nasal.*

The *superior maxillary* nerve passes through the foramen rotundum, and sends nervous twigs to the eye, to the teeth of the upper jaw, and to the muscles of the face.

The *inferior maxillary* nerve escapes from the cavity of the skull through the foramen ovale. Emerging at this opening, the nerve divides into two trunks — external and internal.

The *external trunk*, into which may be traced the whole of the motor root, divides into four branches, which are distributed upon the masseter, temporal, buccal, and pterygoid muscles.

The *internal trunk* divides into three branches — the *gustatory*, the *inferior dental*, and the *auricular.*

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What name is given to the fifth pair of nerves? Why is it classed with the cranial spinal nerves? Give the names of its branches. Where do the filaments of the opthalmic branch ramify? The superior maxillary? Describe the inferior maxillary nerve. Describe its external trunk. How many branches has the internal trunk?

The *gustatory* nerve divides into many filaments, which are distributed to the papillæ, and mucous membrane of the tongue.

The *inferior dental* nerve runs along the canal of the lower jaw bone, distributing branches to the teeth.

The *auricular* nerve is distributed upon the parts about the anterior region of the ear.

Fig. 172.


Fig. 172. Represents the distribution of the fifth pair of nerves. 1, The orbit. 2, The antrum of the upper jaw. 3, The tongue. 4, The lower jaw. 5, The root of the fifth pair of nerves, forming the ganglion of Casser. 6, The first branch of the fifth pair, or opthalmic. 7, The second branch of the fifth pair, or superior maxillary. 8, The third branch of the fifth pair, or inferior maxillary. 9, The frontal branch, dividing into external and internal frontal nerves. 10, The lachrymal branch of the fifth pair. 11, The nasal branch. 12, The internal nasal nerve. 13, The external nasal nerve. 14, The external and internal frontal nerve. 15. The infra-orbital nerve. 16, The posterior dental branches. 17, The middle dental branch. 18, The anterior dental nerve. 19, The terminating branches of the infra-orbital nerve. 20, The malar branch. 21, The pterygoid, or recurrent nerve. 22, The five anterior branches of the third branch of the fifth pair 23, The lingual branch of the fifth, joined by the chorda tympani. 24, The inferior dental nerve. 25, Its mental branches 26, The superficial temporal nerve. 27, The auricular branches. 28, The myio-hyoid branch. x, x, A tooth in the upper and lower jaw, divided, so as to exhibit the roots traversed by nerves from the fifth pair, which ramify on the pulp situated in the crown.

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Where is the gustatory nerve distributed? The inferior dental? The auricular nerve?

## PHYSIOLOGY OF THE TRIFACIAL NERVE.

The fifth pair of nerves is distributed to the parts of the face on which the facial or seventh pair ramifies. The former serves for sensation, the latter for motion. Thus, when the facial nerve is divided, or its functions destroyed by disease, the side affected loses all power of expression, though sensation remains unaffected. On the contrary, if we divide the fifth pair, sensation is entirely destroyed, while expression remains.

One of the branches of the trifacial nerve ramifies on the tongue, and constitutes the nerve of taste. The painful sensations experienced in the face, and in the teeth or jaws, are induced by irritation and disease of a portion of the filaments of this nerve. The unpleasant sensation sometimes experienced when we hear the grating of a file or saw, is produced by the connection of the chordæ tympani nerves, that pass across the drum of the ear, with the fifth nerve.

## ANATOMY OF THE SPINAL CORD.

The spinal column contains the *spinal cord*, or medulla spinalis, the roots of the spinal nerves, and the membranes of the cord, viz., the *dura mater*, *arachnoid*, and *pia mater*.

The *spinal cord* extends from the bridge of Varolius, to the second lumbar vertebra, where it terminates in a rounded point. It presents a difference of diameter in different parts of its extent, and exhibits three enlargements. The uppermost of these is the medulla oblongata; the next corresponds with the origin of the nerves distributed to the upper extremities; the third enlargement is situated near the termination of the cord, and corresponds with the attachment of the nerves which are intended for the supply of the lower extremities.

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What is the function of the fifth pair of nerves? Of the seventh? What is the effect when the motor nerve is destroyed? The nerve of sensation? What nerve ramifies on the tongue? How will you account for the peculiar sensation of the teeth, when hearing the gratings of a file or saw? What does the spinal column contain? Give the extent of the spinal cord. How many enlargements has this cord? What is said of each enlargement?

Fig. 173.

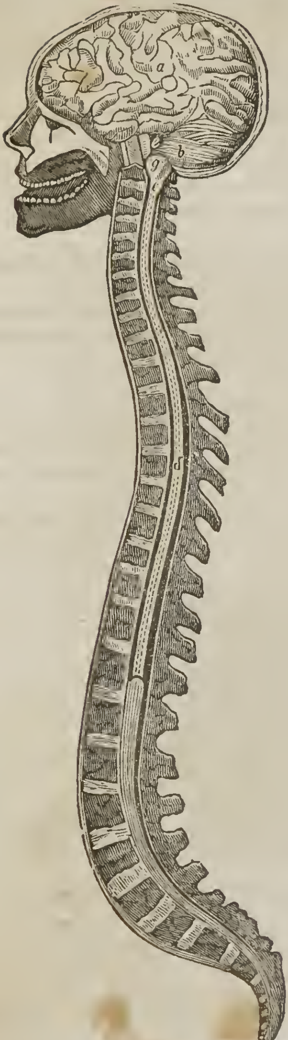

Fig. 174.

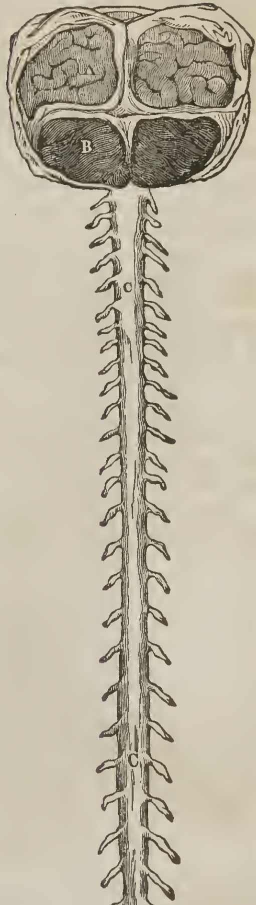

Fig. 173. *a*, The cerebrum. *b*, The cerebellum. *g*, The medulla oblongata. *e*, The pons varolii, or bridge of Varolius *c*, *d*, The spinal cord. The brain, spinal cord, and bones of the vertebral column, are represented as divided into two halves.

Fig. 174. Represents the spinal cord, surrounded by its sheath. A, The posterior lobe of the cerebrum. B, The cerebellum. This is separated from the cerebrum by a process of the dura mater named the tentorium. *c*, *c*, The spinal cord, surrounded by its sheath. Twenty-nine pairs of nerves are seen coming from it, each nerve having an enlargement named a ganglion.

An anterior and posterior fissure divides the spinal cord into two lateral cords. These are united by a thin layer of white substance. The lateral cords are each divided by furrows, into three columns, viz., anterior, lateral, and posterior.

The *anterior* are the motor columns, and give origin to the motor roots of the spinal nerves.

The *posterior* are the columns of sensation, and give origin to the sensitive roots of the spinal nerves.

The *lateral* columns are divided in their function between motion and sensation. They contain the fasciculus described by Sir Charles Bell as the respiratory tract.

## THE SPINAL NERVES.

There are thirty-one pairs of spinal nerves, each arising by two roots — an anterior, or *motive* root; and a posterior, or *sensitive* root.

The *anterior* roots arise from a narrow white line upon the anterior columns of the spinal cord.

Fig. 175.

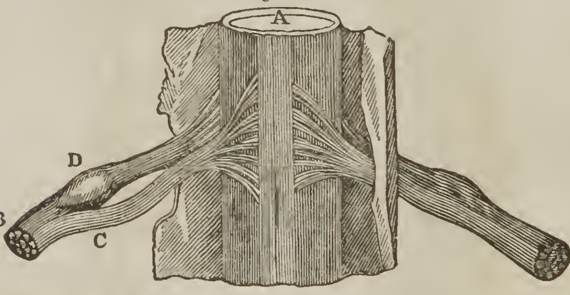


Fig. 175. A Represents the spinal cord, surrounded by its sheath. B, A spinal nerve, formed by the union of the motor root, (C,) and the sensitive root, (D.) At D, the ganglion upon this root is seen.

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Into how many parts is the spinal cord divided? How are these cords united? Name the divisions of the lateral cords. What is the function of the anterior column? The posterior? The lateral columns? How many pairs of nerves issue from the spinal cord? Give the origin of the anterior roots.

The *posterior* roots arise from a narrow gray band formed by the internal gray substance of the cord. They are larger, and the filaments of origin more numerous than those of the anterior roots. A *ganglion* is found upon each of the posterior roots in the foramina, or holes between the bones of the vertebra through which the nerve passes.

Fig. 176.

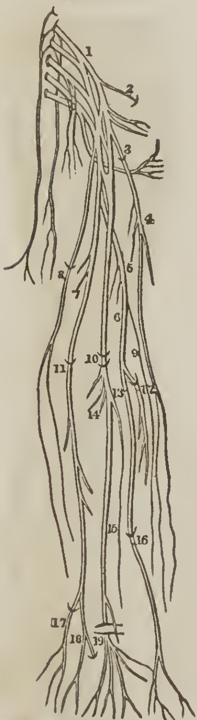

Fig. 177.

Fig. 176. Represents the brachial plexus of nerves with its branches and their distribution on the arm and fore-arm. 1, The brachial plexus. 2, The short thoracic nerves. 3, 4, The external cutaneous nerve. 5, 6, 16, The muscular spiral nerve. 7, 11, The ulnar nerve. 8, The internal cutaneous nerve. 9, The spiral cutaneous nerve. 10, 13, The median nerve. 12, The posterior interosseous nerve. 14, Muscular branches of

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Give the origin of the posterior root. In what respect do the posterior roots differ from the anterior?

the radial nerve. 15, Its interosseous branch. 17, The dorsal branch of the ulnar nerve. 18, The termination of the ulnar nerve, dividing into superficial and deep-seated. 19, The point where the median nerve divides into six branches, which ramify upon the hand and fingers.

Fig. 177. Represents the nerves in front of the fore-arm. 1, The median nerve. 2, The anterior branch of the muscular spiral or radial nerve. 3, The ulnar nerve. 4, The division of the median nerve in the palm to the thumb, to the 1st, 2d, and radial side of the 3d finger. 5, The division of the ulnar nerve to the ulnar side of the 3d and both sides of the 4th finger. The ulnar nerve passes over the point of the elbow, and its distribution explains the sensation experienced in the 4th and one side of the 8d finger, when the elbow receives a blow.

Fig. 178.

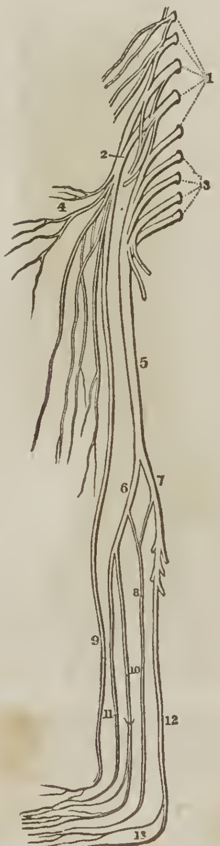



Fig. 179.

Fig. 178. A diagram showing the lumbar and sacral plexuses with the nerves of the lower extremity. 1, The five lumbar nerves, which, with a branch from the last dorsal, constitute the lumbar plexus. 2, The femoral or crural nerve. 3, The four upper sacral nerves, which with the last lumbar, form the sacral plexus. 4, The external cutaneous nerve. 5, The great ischiatic nerve. 6, The peroneal nerve. 7, The popliteal nerve. 8, The external saphenous nerve. 9, The long or internal saphenous nerve. 10, The short saphenous nerve. 11, The anterior tibial nerve. 12, The posterior tibial nerve, dividing at 13 into the two plantar nerves.

Fig. 179. Represents the ramification of the anterior crural nerve. 1, The femoral artery. 2, The femoral vein. 4, Branches of the anterior crural nerve. 3, The saphenous nerve. 5, The inner division of the muscular cutaneous branch of the external popliteal nerves.

Fig. 180.


Fig. 181.

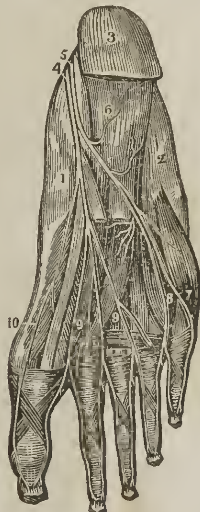
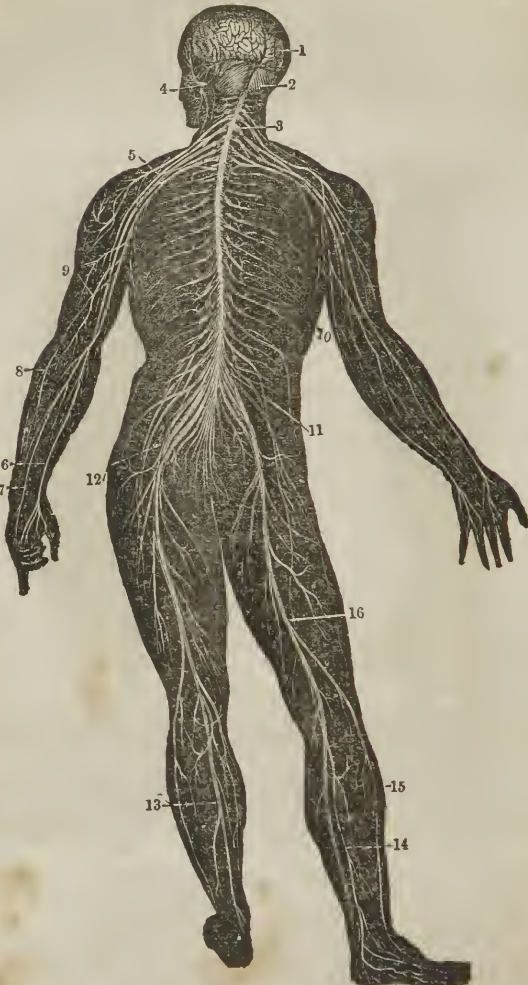



Fig. 180, Represents the posterior tibial nerve in the back of the leg. Some of the large muscles have been removed. 1, The nerve. 2, The nerve where it passes behind the inner ancle to the sole of the foot. It gives off many small branches in the leg, some of which are seen.

Fig. 181, Represents the termination of the posterior tibial nerve in the sole of the foot. 1, The inside of the foot. 2, The outer side of the foot. 3, The heel. 4, The internal plantar nerve. 5, The external plantar nerve. 6, Branch to the flexor brevis muscle. 7, Branch to the outside of the little toe. 8, Branch to the space between the fourth and fifth toes. 9, 9, 9, Digital branches to the remaining spaces. 10, Branch to the internal side of the great toe.

Fig. 182. A posterior view of the brain, and the spinal cord. 1, The cerebrum. 2, The cerebellum. 3, The spinal cord. 4, The facial nerve. 5, The brachial plexus, formed by the union of many nerves which proceed from the spinal cord. 6, The median nerve of the arm. 7, The ulnar nerve. 8, The internal cutaneous nerve. 9, The radial and muscular cutaneous nerve of the arm. 10, The Intercostal nerve. 11, The lumbar plexus, formed by the union of many nerves which proceed from the spinal cord. 12, The sciatic plexus, which gives origin to the principal nerves of the lower extremities. 13, The tibial nerve. 14, The peroneal nerve. 15, The saphenous nerve. 16, The sciatic nerve.

Fig. 182.



After the formation of the ganglion, the two roots unite, and constitute a spinal nerve, which passes through the foramen on the sides of the spinal column.

Each nerve is surrounded by a *neurilema*, or sheath. The nerves divide and subdivide, until their minute filaments ramify on the tissues of the different organs.

The *spinal nerves* are divided into —

| | |
|---|---|
| Cervical, | 8 pairs, |
| Dorsal, | 12 " |
| Lumbar, | 5 " |
| Sacral, | 6 " |

The lower cervical and upper dorsal, pass into each other, and then separate to reunite. This is called the brachial plexus. From this plexus six nerves proceed, which ramify upon the muscles and skin of the upper extremities.

The last dorsal and the five lumbar nerves, form a plexus called the lumbar, similar to that of the cervical. From this there pass six nerves, which ramify upon the muscles and skin of the lower extremities.

The last lumbar and the four upper sacral, unite to form the sacral plexus. From this plexus, five nerves proceed, that are distributed upon the muscles and skin of the hip and lower extremities.

## PHYSIOLOGY OF THE SPINAL CORD AND NERVES.

The *spinal cord*, and *spinal nerves*, possess motor and sensitive tracts and filaments. In those parts that require sensation for their safety and the performance of their functions, there is an abundant supply of sensitive nervous filaments. The muscular fibres that possess the property of shortening are supplied with motor nervous filaments, by the agency of which contractility is induced.

The nerves of sensation are mostly distributed upon the skin. Few filaments ramify upon the mucous membranes. For a description of the structure and functions of the sentient nerves, (See nerves of the skin.)

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When do the two roots unite, and where do they pass? With what is each nerve surrounded? Give the divisions of the spinal nerves. What is called the brachial plexus? How many nerves pass from this plexus? How many nerves from the lumbar plexus, and where do they ramify? How is the sacral plexus formed? Where are the nerves of sensation mostly distributed?

The functions of the muscular are different from those of the sentient nerves. The former are provided for the purpose of motion, and not of feeling. Hence, muscles may be cut and the pain will be slight compared with the cutting of the skin. Weariness is a sensation recognized by one set of muscular nerves. So uniformly is a separate instrument provided for every additional function, that there is strong reason to regard the muscular nerves, although running in one sheath, as in reality double, and performing distinct functions. Sir Charles Bell, in his work on the Nervous System, endeavors to show, that one set of nervous fibres conveys the mandate from the brain to the muscle, and excites the contraction, and that another set conveys from the muscle to the brain, a peculiar sense of the state or degree of contraction of the muscle, by which we are enabled to judge of the amount of stimulus necessary to accomplish the end desired. This is obviously an indispensable piece of information to the mind in regulating the movements of the body. "The muscles have two nerves," says Sir Charles; "which fact has not hitherto been noticed, because they are commonly bound up together. But whenever the nerves, as about the head, go in a separate course, we find that there are a sensitive nerve and a motor nerve distributed to the muscular fibre, and we have reason to conclude, that those branches of the spinal nerves which go to the muscles, consist of a motor and a sensitive filament.

"It has been supposed hitherto, that the office of a muscular nerve is only to carry out the mandate of the will, and to excite the muscle to action. But this betrays a very inaccurate knowledge of the action of the muscular system; for before the muscular system can be controlled under the influence of the will, there must be a consciousness or knowledge of the condition of the muscle.

"When we admit that the various conditions of the muscle must be estimated or perceived, in order to be under the due control of the will, the question naturally arises — Is that

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Why is there less pain in a muscle, when it is cut, than in the skin? What reason have we to suppose that the muscular or motor nerves are double, though enclosed in one sheath? What is the doctrine of Sir Charles Bell on the subject? How does he divide the muscular nerves, and define their separate functions? What error does he contravene as to the office of the muscular nerve?

nerve which carries out the mandate of the will, capable of conveying, at the same moment, an impression retrograde to the course of that influence which is going from the brain to the muscle? If we had no facts in anatomy to proceed upon, still reason would declare to us that the same filament of a nerve could not convey a motion, of whatever nature that motion may be, whether vibration or motion of spirits, in opposite directions at the same time.

"I find that to the full operation of the muscular power, two distinct filaments of nerves are necessary, and that a circle is established between the sensorium and the muscle. One filament or single nerve carries the influence of the will towards the muscles, which nerve has no power to convey an impression backward to the brain. Another nerve connects the muscle with the brain, and acting as a sentient nerve, conveys the impression of the condition of the muscle to the mind, but has no operation in a direction outward from the brain toward the muscle, and does not therefore excite the muscle, however irritated.

"In chewing our food, in turning the eye towards an object, in raising the hand to the mouth, and in fact, in every variety of muscular movement which we perform, we are guided by the muscular sense in proportioning the effort to the resistance to be overcome. When this harmony is destroyed by disease, the extent of the service rendered us, becomes more apparent. The shake of the hand which we see in drunkards, and their consequent incapability of carrying the morsel directly to the mouth, are examples of what would be of daily occurrence, unless we were directed and assisted by a muscular sense."

The proper performance of the functions of the spinal nerves, requires an observance of the conditions suggested in the Physiology of the Brain and Muscular System.

### SYMPATHETIC SYSTEM OF NERVES.

The SYMPATHETIC SYSTEM consists of a series of *ganglia*, extending each side of the spinal column, from the head to

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What are Sir Charles's reasons? What are his views concerning the functions of two distinct filaments? How are we guided by this sense on ordinary occasions? Of what does the sympathetic system of nerves consist?

the coccyx. It communicates with all the other nerves in the body, and distributes branches to all the internal organs. With the exception of the neck, there is a ganglion for each intervertebral space, both of the true vertebræ and sacrum. These ganglia are composed of a mixture of cineritious and medullary matter, and are supposed to be centres of peculiar nervous power.

They are called ganglionic nerves, from the constant disposition they evince to form small knots, or ganglia. Each ganglion may be considered as a distinct centre, giving off branches in four directions, namely, the superior, or ascending, to communicate with the ganglion above; the inferior, or descending, to communicate with the ganglion below; the external, to communicate with the spinal nerves; and the internal, to communicate with the sympathetic filaments, to be distributed to the internal organs.

The branches of distribution accompany the arteries which supply the different organs, and form communications around them, which are called *plexuses*, and take the name of the artery with which they are associated. Thus, we have the mesenteric plexus, hepatic plexus, splenic plexus, &c. All the internal organs of the head, neck, and trunk, are supplied with branches from the sympathetic, and some of them exclusively; hence, it is considered a nerve of organic life.

Fig. 183. Is a beautiful engraving of the sympathetic ganglia and their connection with other nerves. It is from the grand engraving of Manec, reduced in size. A, A, A, The semi-lunar ganglion and solar plexus, situated below the diaphragm and behind the stomach. B, The small splanchnic nerve, formed by filaments from the tenth, eleventh, and twelfth great ganglia. It pierces the diaphragm, and descends to join the renal plexus. C, The great splanchnic nerve. It arises from the sixth dorsal ganglion, and receives filaments from the seventh, eighth, ninth, and tenth dorsal ganglia. It pierces the diaphragm, and terminates in the semi-lunar ganglion. D, D, D, The thoracic ganglia, ten or eleven in number. E, E, The external and internal branches of the thoracic ganglia. G, The right coronary plexus, situated upon the heart. H, The left coronary plexus. I, The inferior cervical ganglion. J, The inferior twigs from this ganglia. K, Its external threads, very slender. L, Its internal twigs, very minute. M, The anterior thread. N, The middle cervical ganglion. O, Its interior twigs. P, Its external twigs. Q, The superior cervical ganglion. R, Its superior branches. S, Its inferior branches. T, The external branch. U, The submaxillary ganglion. V, The vidian nerve. W, Its naso-palatine branch. X, The spheno-palatine ganglion. Z, The auditory nerve and membrane of the tympanum, containing within its cavity four small bones of the ear. 1, The renal plexus of nerves that surrounds the kidneys. 2, The lumbar ganglion. 3, Their internal branches. 4, Their external branches. 5, The aortic plexus of nerves that lies upon the aorta.

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How is the sympathetic system of nerves distributed? What exception? Of what are they composed? Why are they called ganglia? How may each ganglia be considered? Where does the superior or ascending branch communicate? The inferior? The external? The internal? What is a plexus of nerves? From what do they derive their name? Why is the sympathetic considered the nerve of organic life? What is the design of Fig. 183?

Fig. 183.

Fig. 184.

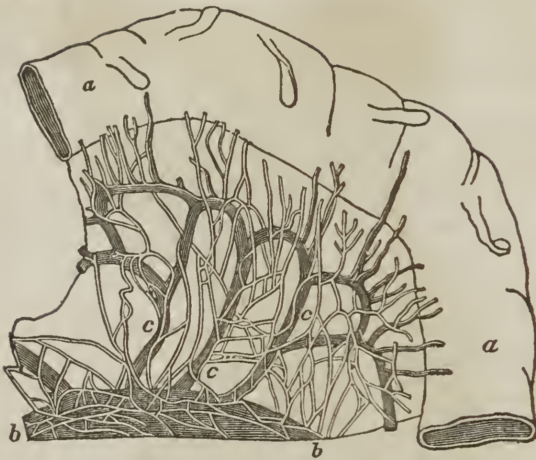


Fig. 184. Represents the distribution of filaments of the sympathetic nerve upon the arteries. *a, a,* A portion of the intestines. *b, b,* Part of the aorta, or great artery. *c, c,* Nerves of the intestines, following the course of the branches of the great artery.

There is good reason to believe, that the peculiar vitality of every organ in the body directly depends on the sympathetic nerves. Some physiologists believe that they preside over the involuntary functions, as absorption, secretion, nutrition, &c. Others suppose the office of the ganglions is to render organs which are supplied with nerves from them, independent of the will. Every part of the body must, to a certain extent, be under their influence, as filaments from this system of nerves, accompany the blood-vessels throughout their course.

The most important use of the sympathetic system is to form a communication of one part of the system with another, so that one organ can take cognizance of the condition of every other, and act accordingly. If disease sieze the brain, for example, the stomach, by its sympathetic connection, knows

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What does Fig. 184 represent? What is the opinion of some physiologists as to the functions of the sympathetic nerves? The opinion of others?

it; and as nourishment would add to the disease, it refuses to receive food, and perhaps throws off what has already been taken. Loss of appetite in sickness is thus a kind provision of nature, to prevent our taking food when it would be injurious, and following this intimation, we, as a general rule, should abstain from food till the appetite returns.

# CHAPTER XI.

## THE FIVE SENSES.

SENSATION is the perception of external objects by means of the senses. There are five senses, namely, *touch*, *taste*, *smell*, *hearing*, and *vision*.

### SENSE OF TOUCH.

TOUCH is the sense which reveals to us the contact of foreign bodies with our organs, and informs us of the nature of their surfaces, whether rough or smooth, their movements, the degree of their consistence, their temperature, and, to a certain extent, their form, volume, and weight.

In man, the hand is the special organ of touch, and its structure is admirably well adapted to the exercise of this sense. The fineness of the skin, its great sensibility, the species of cushion, formed by the subcutaneous fat at the extremities of the fingers, the length and flexibility of these organs, and the capability of opposing the thumb to the fingers, like a pair of forceps, are so many conditions essentially favorable to the delicacy of this sense, and enable us to appreciate with exactitude the qualities of the bodies we may feel.

"Physiologists make a distinction between tact and touch. Tact, with some few exceptions, is generally diffused through all the organs, and more particularly over the skin. This exists in all animals, while touch exists chiefly in the fingers of man, in the antennæ of insects, and in the noses of certain quadrupeds.

"In the exercise of these functions, tact is considered passive, as when any part of the system comes into contact with another body, a sensation of its presence is given, without the exercise of volition. On the contrary, touch is active, and is

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*Define sensation.* How many senses have we? *Define touch.* What is the organ of touch in man? What are the circumstances which render the hand so admirably adapted to its purpose? What is the difference between touch and tact? In the exercise of these functions, which is active, and which passive?

exercised voluntarily, for the purpose of conveying to the mind a knowledge of the qualities or properties of the surfaces of bodies; as when we feel of a piece of cloth to ascertain its qualities, or a polished surface, to prove its smoothness."

The nerves in which this sense is situated proceed from the anterior half of the spinal cord.

## ANATOMY OF THE ORGANS OF TASTE.

The chief organ of TASTE is the upper surface of the tongue; though the lips, the palate, the internal surface of the cheeks, and the upper part of the œsophagus, participate in this function.

Fig. 185.

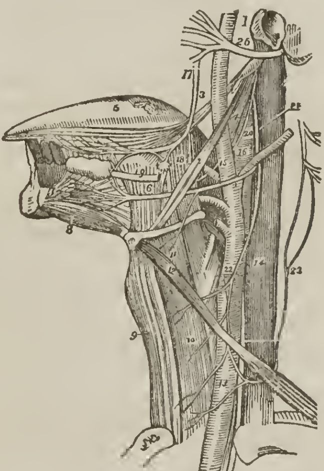

Fig. 185. Gives a view of one side of the neck, showing the nerves of the tongue. 1, A fragment of the temporal bone, containing the meatus auditorius externus, mastoid and styloid processes. 2, The stylo-hyoideus muscle. 3, The stylo-glossus. 4, The stylo-pharyngeus. 5, The tongue. 6, The hyo-glossus muscle; — its two portions. 7, The genio-hyo-glossus muscle. 8, The genio-hyoideus; — they both arise from the inner surface of the symphysis of the lower jaw. 9, The sterno-hyoideus muscle. 10, The sterno-thyroideus. 11, The thyro-hyoideus, upon which the hyoid branch of the lingual nerve is seen ramifying. 12, The omo-hyoideus, crossing the common carotid artery (13), and internal jugular vein (14). 15, The external carotid. 16, The internal carotid. 17, The gustatory nerve, giving off a branch to the submaxillary ganglion

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*What is the chief organ of taste?* What other parts participate in the function? Explain Fig. 185.

(18), and communicating a little further on with the hypo-glossal nerve. 19, The sub-maxillary or Wharton's duct. 20, The glosso-pharyngeal nerve. 21, The hypo-glossal nerve, curving around the occipital artery. 22, The descendens noni nerve, forming a loop with the communicans noni, (23), which is seen arising by filaments from the upper cervical nerves. 24, The pneumo-gastric nerve, emerging from between the internal jugular vein and common carotid artery, and entering the chest. 25, The facial nerve, emerging from the stylo-mastoid foramen, and crossing the external carotid artery.

The tongue is chiefly composed of muscular fibres, which run in almost every direction. It possesses great versatility of motion, and can be moulded into a great variety of shapes. In articulation, mastication, and deglutition, the tongue is an auxiliary to other organs.

This organ is abundantly supplied with blood-vessels. It receives nervous filaments from the fifth, eighth, and ninth pairs of nerves. The *fifth*, called the gustatory, is the nerve of *taste* and *sensibility;* the *ninth*, called the hypo-glossal, of *voluntary* motion. By means of the *eighth*, called the glosso-pharyngeal, the tongue is brought into association with the throat, œsophagus, and larynx.

The surface of the tongue is thickly studded with fine papillæ, or *villi*, which give the organ a velvety appearance. These villi are of three varieties. The first is located near the root of the tongue. They belong to the class of mucous follicles. They are larger than the others, and are called *lenticular*, from being shaped like a lens. These, together with the tonsils, sometimes called the almonds of the ears, secrete mucus, to lubricate the food in the act of deglutition.

The instruments of taste are the other two sets of papillæ. One set consists of small, oval-shaped bodies, which are scattered over the whole surface of the tongue. They give it a rough, shaggy appearance, and are named the *conical filiform* papillæ.

The other set of papillæ is named the *fungiform*. They are larger than the former, and consist of small rounded heads, supported on short stalks, something in the shape of mushrooms, from which they derive their name. In these sensitive papillæ, the gustatory branch of the fifth pair of nerves ramifies.

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Describe the structure of the tongue. From what source does the tongue derive its nerves? What is the appearance of the surface of the tongue? What is the office of the mucous papillæ? Of the conical and fungiform papillæ? What nerve ramifies in the fungiform papillæ?

## PHYSIOLOGY OF THE SENSE OF TASTE.

TASTE is the sense which makes us acquainted with the savor of substances. When fluids are taken into the mouth, the papillæ dilate and erect themselves, and the sense of taste is conveyed to the brain through filaments of the gustatory nerve.

If dry, solid food be taken, the tongue carries it to the back side of the mouth, where it receives secretions from the salivary glands; the saliva becoming impregnated with its flavor, flows over the sides of the tongue, and gives to the papillæ a perception of the savory juice; this sensation is then communicated to the brain.

It is supposed that the salts which enter into the composition of the saliva, are very efficient agents in reducing substances to a proper state for making impressions on the nerves of taste. In this way we can account for the fact that *metals* impart a peculiar taste, although they are insoluble in water.

The primary use of taste is to guide animals in the selection of their food, and warn them against the introduction of noxious articles into the stomach. In all the inferior animals, we see that the original design of taste is still answered. But in man, this sense has been so abused and perverted, by the introduction of stimulants, and the endless admixture of different articles of food, that the simple action of this part seems to have been superseded almost entirely by acquired taste.

## SENSE OF SMELL.

This sense is located in the air-passages of the nose. To understand the philosophy of smell, the structure of the nose and nasal cavities, with the distribution of the olfactory nerves, must be first examined.

## ANATOMY OF THE ORGANS OF SMELL.

The nose is composed of 1, The *skin*. 2, The *muscles*. 3, The *bones*. 4, The *fibro-cartilages*. 5, *Mucous membrane*.

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What is taste? What is the process of taste? What is the primary use of taste? In what animals is this design still answered? How is it with man? *Where is the sense of smell located?* What is necessary before the philosophy of smell can be understood?

6, The *blood-vessels* and *nerves.* The skin and muscles have been described in Chaps. II. and IV.

The BONES of the nose are the nasal, and the nasal processes of the upper jaw.

The FIBRO-CARTILAGES give form and stability to the frame-work of the nose, providing at the same time, by their elasticity, against injuries. They are five in number.

The MUCOUS MEMBRANE, lining the interior of the nose, is continuous with the skin externally, and with the lining membrane of the nasal cavities within. Around the entrance of the nostrils it is provided with numerous hairs.

The ARTERIES are branches of the carotid.

Fig. 186.

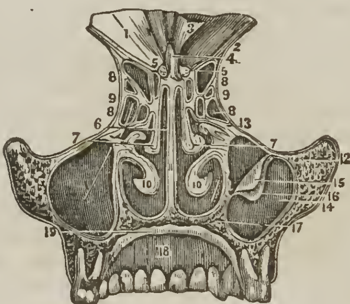


Fig. 186. Represents a vertical section of the middle part of the nasal cavities, giving a posterior view of the arrangement of the ethmoidal cells. 1, The anterior fossæ of the cranium. 2, The same, covered by the dura mater. 3, The dura mater turned up. 4, The crista galli of the ethmoid bone. 5, Its cribriform plate. 6, Its nasal plate. 7, The middle spongy bones. 8, The ethmoidal cells. 9, The os planum. 10, The inferior spongy bone. 11, The vomer. 12, The upper jaw. 13, Its union with the ethmoid. 14, The anterior walls of the antrum of the upper jaw, covered by its membrane. 15, Its fibrous layer. 16, Its mucous surface. 17, The palatine process of the upper jaw bone. 18, The roof of the mouth covered by mucous membrane. 19, A section of this membrane. A bristle is seen in the orifice of the antrum of the upper jaw.

The NERVES are from the fifth and seventh pairs, under the influence of which the nasal muscles act.

The *nasal fossæ* are two irregular compressed cavities, extending from the nose to the pharynx. These cavities are

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What bones form the frame-work of the nose? What is the use of the cartilages? What relation has the *mucous membrane* with other membranes of the nose? What arteries supply this organ? What nerves? Describe the nasal cavities.

bounded superiorly by the sphenoid and ethmoid bones; inferiorly by the hard palate. In the middle line they are separated from each other by a bony and fibro-cartilaginous septum; upon the outer wall of each fossa, in the dried skull, are three projecting processes, termed spongy bones. In the fresh fossa, these are covered by a mucous membrane. The space that intervenes between the superior and middle spongy bone is termed the *superior meatus*, or channel; the space between the middle and inferior bone is the *middle meatus*, and that between the inferior bone and the floor of the fossa, is the *inferior meatus*.

Fig. 187.

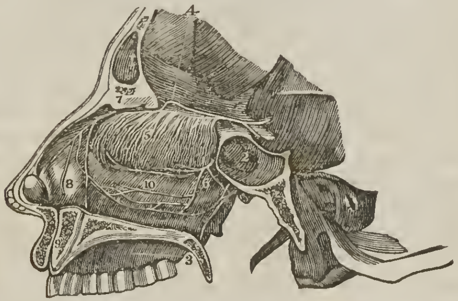

Fig. 187. Represents the first pair or olfactory nerves, with the nasal branches of the fifth pairs. 1, The frontal sinus. 2, The sphenoidal sinus. 3, The hard palate. 4, The bulb of the olfactory. 5, Branches of the olfactory nerve on the superior and middle turbinated bones. 6, The spheno-palatine nerve from the second branch of the fifth pair. 7, The internal nasal nerve from the first branch of the fifth pair. 8, branches of the nerve (7,) to the lining membrane of the nose. 9, The ganglion of Cloquet in the foramen incisivum. 10, The anastomosis of the branches of the fifth pair on the inferior turbinated bone.

The *meatuses* are passages that extend from before, backwards. Into these are several openings. They are lined with a mucous membrane, named the *pituitary*, or *Schneiderian*, from Schneider, who first showed that the secretion proceeded from the mucous membrane, and not from the brain.

Upon the mucous membrane of the meatuses, the olfactory nerve ramifies, and also a branch of the fifth pair of nerves.

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What is found on the outer wall of each fossa, in the dried skull? In the fresh skull? What are meatuses? Why was the lining membrane of these passages called the Schneiderian? Where does the olfactory nerve ramify?

The distribution of the filaments of these nerves, will be understood by examining fig. 187, on the preceding page.

### PHYSIOLOGY OF THE SENSE OF SMELL.

During the act of inspiration the air rushes through the meatuses. The odorant particles contained in the atmosphere are brought in contact with the fine filaments of the first and fifth pairs of nerves. The impression made upon these nerves is transmitted to the brain.

Acuteness of smell requires that the brain and nerves be in a state of health, and that the mucous membrane lining the nasal cavities, be thin and moistened with mucus. *Snuff* and other irritants, render the sense of smell obtuse, by diminishing the sensitiveness of the nerves, and by thickening and otherwise altering the structure of the mucous membrane.

The sense of smell, like that of taste and touch, may be improved by education. It likewise varies in different persons. In some animals, as the bloodhound, this sense is remarkably acute. He not only tracks the hare, or the fox, with unerring certainty, long after their footsteps have been imprinted, but he will even trace the progress of his master through thickly crowded streets, distinguishing his footsteps from those of a thousand others, and amidst the odorous particles emanating from a thousand sources.

### SENSE OF VISION.

The visual apparatus consists of the second pair, or *optic nerves, the eyeballs and their appendages.*

The OPTIC NERVE arises by two roots, one from the *thalami optici*, and the other from the *corpora quadrigemina.* The two nerves approach each other, as they proceed forward, and a portion of the fibres of each, cross to the nerve of the opposite side. They then diverge and enter the globe of the right eye, through the posterior part of the sclerotic and choroid coats, and then expand, and form a soft, whitish membrane, called *retina.*

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How does the mind become sensible of odoriferous particles? On what does the acuteness of smell depend? Why does *snuff* render the sense of smell obtuse? Can the sense of smell be improved by education? What is said of the acuteness of smell in the bloodhound? Of what does the visual apparatus consist? Describe the course of the *optic nerve.*

Fig. 188.

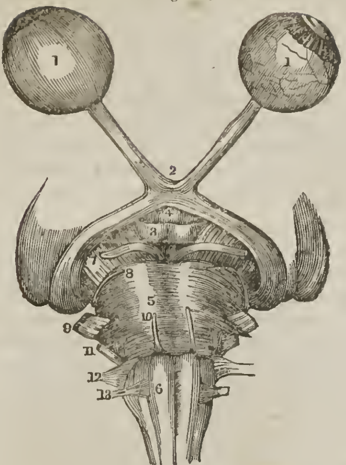


Fig. 188. Represents the second pair or optic nerves, with the origin of seven other pairs. 1, 1, The globe of the eye. The one on the left hand is perfect, but that on the right has the sclerotic coats removed to show the retina. 2, The crossing of the optic nerves. 3, The corpora albicantia. 4, The infundibulum. 5, The pons varolii. 6, The medulla oblongata. 7, The third pair of nerves. 8, The fourth pair. 9, The fifth pair. 10, The sixth pair. 11, The seventh pair. 12, The eighth pair. 13, The ninth pair.

The form of the eye-ball is that of a sphere, of about one inch in diameter. It has the segment of a smaller sphere ingrafted upon its anterior surface, which increases its antero-posterior diameter. The axes of the eye-balls are parallel to each other, but do not correspond to the axes of the orbits, which are directed outward. The optic nerves follow the direction of the orbits, and therefore enter the eye-balls at their nasal side.

The globe of the eye is composed of *tunics*, or coats, and refracting media, named *humors*. The tunics are three in number: 1, The *sclerotic* and *cornea*. 2, The *choroid*, *iris*, and *ciliary processes*. 3, The *retina* and *zonula ciliaris*.

COATS. — The SCLEROTIC coat is a dense, fibrous membrane, and invests about four-fifths of the globe of the eye.

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What does Fig. 188 exhibit? What is the form of the eye-ball? How are the axes of the eye-balls situated? Mention the different parts of which the globe of the eye is composed. Describe the *sclerotic* coat.

This gives the form to the eye-ball. Its anterior surface is covered by a thin, tendinous layer, derived from the expansion of the tendons of the four recti muscles, and is named the *tunica albuginea.* This tunic is covered, for a part of its extent, by the mucous membrane (conjunctiva,) of the front of the eye, and by reason of the brilliancy of its whiteness, gives occasion to the common expression, "the white of the eye." Anteriorly, the sclerotic coat presents a bevelled edge, which receives the cornea in the same way that a watch-glass is received by the groove in its case.

The CORNEA is the transparent projecting layer, that forms the anterior fifth of the globe of the eye. In form, it is circular convexo-concave, and resembles a watch-glass. It is received by its edge which is sharp and thin, within the bevelled border of the sclerotic, to which it is firmly attached. The cornea is composed of four layers.

The CHOROID is a vascular membrane, of a rich chocolate-brown color upon its external surface, and of a deep black within. It is connected, externally, to the sclerotic by an extremely fine cellular tissue, and by the passage of nerves and vessels; internally, it is in contact with the retina. The choroid membrane is composed of three layers: 1. The external coat, which consists, principally, of veins, arranged in a peculiar manner. 2. The middle coat is formed principally by the ramification of minute arteries. It secretes upon its surface the pigmentum nigrum, and is reflected inwards at its junction with the ciliary ligament, so as to form the ciliary processes. 3. The internal layer is a delicate membrane, called the *pigmentum nigrum.*

The CILIARY LIGAMENT, or circle, is the bond of union between the external and middle coats of the eye, and serves to connect the cornea and sclerotic, at their junction with the iris and external layer of the choroid.

The IRIS is so named from its variety of color in different persons. It forms a partition between the anterior and posterior chambers of the eye, and is pierced by a circular opening

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Why is it sometimes called the "white of the eye?" Describe the cornea. Describe the choroid coat. How is it connected with the sclerotic coat? Of how many layers is the choroid membrane composed? Of what does the first layer consist? The second? The third? What is the bond of union between the external and middle coat of the eye? What is the iris, and why so called? What membrane separates the anterior and posterior chambers of the eye?

which is called the *pupil.* It is composed of two layers. 1. The anterior or muscular, which consists of radiating fibres; these converge from the circumference towards the centre. Through the action of these radiating fibres the pupil is dilated. 2. The circular fibres, which surround the pupil like a sphincter, and by their action produce contraction of its area. The posterior layer is of a deep purple tint, and is called *uvea,* from its resemblance in color to a ripe grape.

Fig. 189.

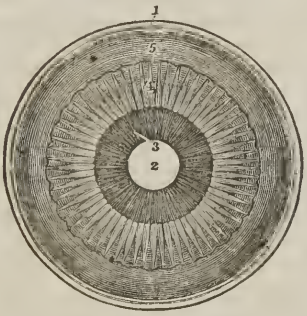


**Fig. 189.** Represents the anterior segment of a transverse section of the globe of the eye, seen from within. 1, The divided edge of the three coats, — sclerotic, choroid, and retina. 2, The pupil. 3, The iris; the surface presented to view in this section being the uvea. 4, The ciliary processes. 5, The scalloped anterior border of the retina.

The CILIARY PROCESSES consist of a number of triangular folds, formed, apparently, by the plaiting of the internal layer of the choroid coat. They are about sixty in number. Their external border is connected with the ciliary ligament, and is continuous with the internal of the choroid. The central border is free, and rests against the circumference of the crystalline lens. These processes are covered by a layer of the pigmentum nigrum.

The third tunic of the eye is the RETINA, which is prolonged forward to the lens by the zonula ciliaris. The retina is composed of three layers, the external, middle or nervous, and internal or vascular. The external membrane is extremely

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Of how many layers of fibres is the iris composed? What is the function of the radiating fibres? Of the circular? What is the color of the posterior layer of the iris? What does Fig. 189 exhibit? How are the ciliary processes formed? Of how many layers is the retina composed?

thin, and is seen as a flocculent film, when the eye is suspended in water. It is called Jacob's membrane. The nervous membrane is the expansion of the optic nerve, and forms a thin, semi-transparent, bluish-white layer. The vascular membrane consists of the ramification of a minute artery and its accompanying vein. This vascular layer forms distinct sheaths for the nervous papillæ, which constitute the inner surface of the retina. The zonula ciliaris is a thin vascular layer, which connects the anterior margin of the retina with the anterior surface of the crystalline lens, near its circumference.

HUMORS. — The humors are three in number; the *aqueous*, *crystalline*, and *vitreous*.

The *aqueous humor* is situated in the anterior and posterior chambers of the eye. It is an albuminous fluid having an alkaline reaction. Its specific gravity is a very little greater than distilled water. The anterior chamber is the space intervening between the cornea, in front, and the iris and pupil, behind. The posterior chamber is the narrow space, less than half a line in depth, bounded by the posterior surface of the iris and pupil, in front, and by the ciliary processes and lens, behind. The two chambers are lined by a thin layer, the secreting membrane of the aqueous humor.

The *crystalline humor*, or lens, is situated immediately behind the pupil. It is surrounded by the ciliary processes, is more convex on the posterior than on the anterior surface, and, in different portions of the surface of each, the convexity varies from their oval character. It is imbedded in the anterior part of the vitreous humor, from which it is separated by the hyaloid membrane, and is invested by a transparent elastic membrane, called the capsule of the lens. The lens consists of concentric layers, disposed like the coats of an onion. The external layers are soft, the next firmer, and the central form a hardened nucleus. These layers are best demonstrated by boiling or by immersion in alcohol, when they separate easily from each other.

The *vitreous humor* forms the principal bulk of the globe of the eye. It is an albuminous fluid, resembling the aqueous

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What is the appearance of the external layer of the retina? Describe the nervous membrane. The vascular. What is the zonula ciliaris? Where is the aqueous humor situated? What part of the eye is called the anterior chamber? The posterior chamber? With what are the chambers lined? Where is the crystalline humor situated? With what is it surrounded? Of what does the lens consist? Describe the vitreous humor.

humor, but is more dense, and differs from the aqueous in this important particular, that it has not the power of re-producing itself; so that if by accident it is discharged, the eye is irrecovably lost; while the aqueous humor may be let out and will be again restored. It is enclosed in a delicate membrane, called the hyaloid, which sends processes into the interior of the globe of the eye, forming cells in which the humor is retained.

Fig. 190.

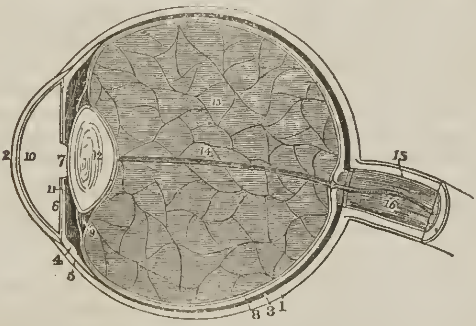


Fig. 190. Represents a longitudinal section of the globe of the eye. 1, The sclerotic coat, thicker behind than in front. 2, The cornea, received within the anterior margin of the sclerotic, and connected with it by means of a bevelled edge. 3, The choroid coat, connected anteriorly with the ciliary ligament (4), and the ciliary processes (5). 6, The iris. 7, The pupil. 8, The third layer of the eye, the retina terminating anteriorly by an abrupt border at the commencement of the ciliary processes. 9, The canal of Petit, which encircles the lens (12). The thin layer in front of this canal is the zonula ciliaris, a prolongation of the vascular layer to the retina. 10, The anterior chamber of the eye, containing the aqueous humor; the lining membrane by which the humor is secreted is represented in the diagram. 11, The posterior chamber. 12, The crystalline lens, more convex behind than before, and enclosed in its proper capsule. 13, The vitreous humor, enclosed in the hyaloid membrane, and in cells formed in its interior by that membrane. 14, A tubular sheath of the hyaloid membrane, which serves for the passage of the artery of the capsule of the lens. 15, The neurilema of the optic nerve. 16, The arteria centralis retinæ, embedded in its centre.

## PHYSIOLOGY OF THE EYE.

The sclerotic is a membrane, that gives form to the body of the eye, and protection to the interior and more delicate parts. The choroid coat seems to be chiefly composed of a tissue of nerves and minute blood-vessels, which give nourishment to the different parts of the eye. The pigmentum nigrum, or black paint, which lines its inner surface, is of

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What membrane encloses the vitreous humor? Describe Fig. 190. *What is the function of the sclerotic coat?* Of the choroid membrane? What is the office of the pigmentum nigrum?

great importance in the function of vision; by it all luminous rays not necessary for vision are absorbed.

In albinos, where there is an absence of pigmentum nigrum, the rays of light traverse the iris, and even the sclerotic, and so overwhelm the eye with light, that their vision is quite imperfect, except in the dimness of evening or at night. In the manufacture of optical instruments, care is taken to color their interior black, for the same object, namely, the absorption of scattered rays.

The iris, by means of its powers of expansion and contraction, regulates the quantity of light admitted through the pupil. If the iris be thin, and the rays of light pass through its substance, they are immediately absorbed by the uvea, and if that layer be insufficient, they are taken up by the black pigment.

The lamellated cornea, the aqueous, crystalline, and viteous humors, are transparent; so that rays of light traverse these parts of the eye, and fall upon the retina. The office of these humors and the cornea is to refract the rays of light in such proportion as to direct the image in the most favorable manner upon the retina.

Different degrees of density modify the refractory power of any transparent medium. It is found, on examination, that the cornea, the vitreous, crystalline, and aqueous humors, have each, severally, various degrees of density. The density of the crystalline lens at its circumference, varies from its centre. These circumstances modify the direction of the refraction of the rays of light in their passage from the cornea to the retina.

The refracting powers of the plane, convex, concave, plano-convex, plano-concave, and concavo-convex media, are different. The cornea and aqueous humors are convexo-concave, the vitreous humor is concavo-convex, while the crystalline humor is a convexo-convex medium. See Fig. 190.

The different degrees of convexity or concavity also modify the refracting character of transparent media. The crystalline lens is of different degrees of convexity on its two sides. The convex surfaces of the aqueous and vitreous humors are

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What is the effect, when there is an absence of the paint on the choroid coat? Why are optical instruments colored black on the interior surface? What is the function of the iris? What is the character of the humors of the eye? What is the office of the cornea and humors? What is said of the density of the crystalline lens? What kind of lenses do the various humors exhibit? What modifies the refracting powers of lenses?

segments of circles, of different diameters from their concave surfaces. See Fig. 190. All these circumstances still further influence the refracting character of the visual organ. The achromatic arrangement of the transparent refracting media of the eye, remedies the aberration of refraction in the different portions of the eye.

Fig. 191.

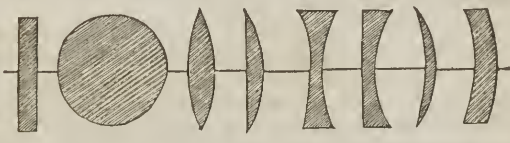


Fig. 191. Represents the forms of the different lenses. 1, A plane lens. 2, A globe lens. 3, A convexo-convex lens. 4, A plano-convex lens. 5, A concavo-concave lens. 6, A plano-concave lens. 7, Meniscus. 8, A concavo-convex lens.

Again, the refracting power of lenses is modified by their convexity or concavity. The more convex a lens is, the shorter the distance from the refracting medium, when the different refracted rays converge to a focus. To adapt the eye to view objects at different distances requires a change in the refracting power of some of the transparent media of the eye. Both surfaces of the crystalline lens are oval, not spherical, and the refraction of the rays of light is mainly effected in this portion of the eye. Change the inclination of this lens, so that different portions of its anterior surface shall be directly behind the pupil, and its refracting power is increased or diminished, as the surface presented is more or less convex.

To view objects at a distance, a more convex lens is needed than in examining articles very near the eye. The eye has the power of adaptation to different distances. The action of the ciliary processes changes the inclination of the crystalline lens, which modifies the refraction of rays of light proceeding from objects to which the eye is directed. Without this or some other adapting power, a picture of objects at different distances, would not be formed upon the retina, and the

NOTE. In studying this page, the pupil should examine the form of the cornea, aqueous, crystalline, and vitreous humors, as represented in Fig. 190.

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What is the function of the different lenses of the eye? Has the eye the power of adapting itself to different distances?

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vision of every person would be defective, except in reference to objects at certain definite distances from the eye.

The refracting character of differently formed lenses is illustrated in the works on Natural Philosophy, to which the pupil is referred. Where the refracting medium is too great, as in over-convexity of the cornea and lens, the image falls short of the retina, producing near-sightedness; and where it is too little, the image is thrown beyond the nervous membrane, or retina, producing far-sightedness.

These conditions are rectified by the use of spectacles, which provide a differently refracting medium externally to the eyes, and thereby correct the transmission of light.

Vision results from impressions made upon the mind by the picture of an object painted at the back part of the globe of the eye, or on the retina; and the optic nerve is the medium of communication between the eye and the brain.

Fig. 192.

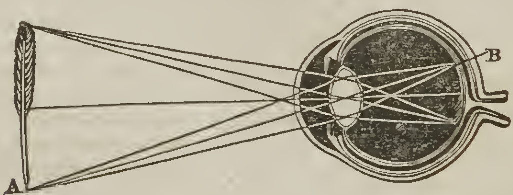


Fig. 192. A, Represents an arrow, an inverted image of which is painted on the retina of the eye, at B. The image of all objects upon the expansion of the optic nerve is inverted by the crossing of the rays of light from objects as they traverse the pupil.

## APPENDAGES OF THE EYE.

The appendages of the eye are the *eye-brows*, *eye-lids*, *conjunctiva*, and the *lachrymal apparatus*.

The EYE-BROWS are two projecting arches of integument, covered with short, thick hairs, which form the upper boundaries of the orbit. The eye-brows are so arranged that they prevent the moisture that accumulates on the forehead, in free perspiration, from flowing into the eye.

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What is the cause of near-sightedness? Of far-sightedness? How can these defects be remedied? What is the medium of communication between the eye and brain? *Name the appendages of the eye.* Describe the eye-brows.

The EYE-LIDS are two valvular layers placed in front of the eye.

The tarsal cartilages are two thin layers of fibro-cartilage, about an inch long, which give form and support to the eye-lid.

The meibomian glands are imbedded in the internal surface of the cartilages, and are very distinctly seen on examining the inner surface of the eye-lids. They have the appearance of parallel strings of pearls. They open by minute apertures upon the edges of the lids.

The secretion from these glands prevents the edges of the eye-lids from being united during sleep.

The edges of the eye-lids are furnished with a triple row of long thick hairs, which curve upwards from the upper lid, and downwards from the lower, so that they may not interlace with each other in the closure of the eye-lids.

The eye-lids, by closing, not only protect the eye from moisture, but from dust, particularly during sleep. They, likewise, by their movements in opening and shutting, spread the lubricating fluid equally over the eye.

The CONJUNCTIVA is the mucous membrane of the eye. It covers the whole of the anterior surface, and is then reflected upon the lids, so as to form their internal layer. In this membrane is secreted the fluid that moistens and lubricates the eye and which causes the eye-lids to open and shut without friction.

The LACHRYMAL APPARATUS consists of the *lachrymal gland*, with its excretory ducts; the *puncta lachrymalia*, and *lachrymal canals;* the *lachrymal sac*, and *nasal duct.*

The LACHRYMAL GLAND is at the upper and outer angle of the orbit. It is about three quarters of an inch in length, flattened and oval in shape, and occupies a depression in the orbital plate of the frontal bone. Ten or twelve small ducts pass from this gland to the border of the tarsal cartilage of the upper eye-lid, where they open on the surface of the conjunctiva.

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Describe the eye-lids. Of what do the tarsal cartilages consist? Where are the meibomian glands situated? What do the meibomian glands resemble? With what are the edges of the eye-lids furnished? What is said of the arrangement and use of the eye-lids? Describe the conjunctiva. Of what does the lachrymal apparatus consist? Where is the lachrymal or tear gland situated?

The LACHRYMAL CANALS commence at minute openings upon the edge of the eye-lids. These openings are called puncta lachrymalia. The canals terminate in the lachrymal sac.

Fig. 193.

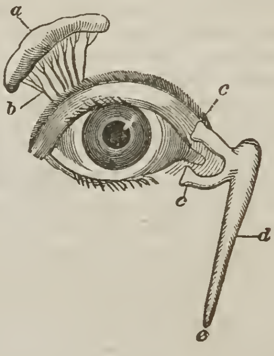


Fig. 193. *a*, Represents the lachrymal gland. *b*, Ducts leading from the lachrymal gland to the upper eye-lid. *c*, *c*, The puncta lachrymalia. *d*, The nasal sac. *e*, The termination of the nasal duct.

The LACHRYMAL SAC is the upper part of the nasal duct, and is but little larger than the canal.

The NASAL DUCT is a short canal, about three quarters of an inch in length, directed downwards and backwards, to the inferior channel of the nose, where it terminates by an expanded orifice.

The fluid (tears) secreted by the lachrymal gland, is conveyed to the eye by the small ducts before described. It is then imbibed by the puncta lachrymalia, and carried by the lachrymal canals into the lachrymal sac, from which it is passed to the nasal cavities by the nasal ducts. When the secretion of the lachrymal gland is very copious, as in weeping, the lachrymal canals are too small to convey it to the nasal passages as fast as secreted, and it flows over the cheeks. If the lachrymal canals or nasal ducts become ob-

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Where do the lachrymal canals commence? Where is the lachrymal sac situated? The nasal duct? Where are the tears secreted? Where conveyed? Why do tears flow over the cheeks instead of entering the nasal ducts?

structed or obliterated, there is a constant flow of fluid over the cheeks. The opening of the canals or ducts, by a surgical operation, is the only effectual remedy.

A large branch from the fifth pair of nerves, (which is a nerve of sensibility) ramifies upon the different parts of the eye and its appendages. Those parts, however, receive some nervous filaments from the seventh pair. The large number of sensitive nervous filaments renders the visual organ very impressible to bodies that cause irritation, as dust, or intense light. This compels us to use due care to shield the eye from the influence of agents that would impair or destroy vision.

## PRACTICAL SUGGESTIONS.

1. Action or use, alternated with rest, should be observed in relation to the eye as well as other organs. If the eye be kept fixed intently, for a long time, on an object, it will become exhausted, and the power of sight diminished. The observance of this rule is particularly needful to those whose eyes are weak, and predisposed to inflammation.

2. Although the iris dilates and contracts, as the light that falls upon the eye is faint or strong, this dilatation or contraction is not instantaneous. Hence, the imperfect vision noticed in passing from a strong to a dim light, and the overwhelming sensation experienced on emerging from a dimly lighted apartment to the bright light of the meridian sun. Sudden transitions should be avoided, as they tend to induce disease, and paralysis of the retina. Likewise, using the eye a long time, in a very intense light, is one of the most common causes of amaurosis, or paralysis of the retina.

3. If the eye be turned obliquely in viewing objects, it may produce an unnatural contraction of the muscle called into action. This contraction of the muscle is termed *strabismus*, or cross-eye. The practice of imitating the appearance of a person thus affected, is injudicious, as the imitation designed to be temporary, may become permanent. For the same

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What nerves ramify upon the eye? Why is the eye so impressible? Do the same principles apply to the eye as to the muscular system? What is the effect, if the eye be kept in one position a long time? How is amaurosis, or decay of sight often produced? How is the cross-eye frequently produced?

reason, a young child should not be permitted to examine objects by turning its eye obliquely.

4. Any action, unnatural to the muscles, if frequently repeated, may and will modify the character and action of the parts so operated upon. If a limb, as the arm, be kept flexed for a long time, one set of muscles will be relaxed and elongated, and another will be shortened, and its contractile power will be increased. The same principle is true of the eye. In viewing objects very near the eye, the ciliary processes are called into action to produce a proper inclination of the crystalline lens, so that the rays of light may be properly refracted to form a perfect image on the retina. In looking at objects at a great distance, the ciliary processes are called into a different action, to produce a different inclination of the lens. Let either of these actions be repeated, again and again, for weeks and months, and they will become natural, and the acquired inclination will be permanent. Hence, a person becomes near or long-sighted, as the objects to which the eye is usually directed are near or remote. This is one reason why scholars, watchmakers, and artisans, who bring minute objects near the eye to examine them, are near-sighted, and why hunters and sailors, who are habituated to view objects at a distance, are long-sighted. Children should be trained to use the eye upon objects at different distances, so that the vision may be correct when objects at various distances are viewed.

## ANATOMY OF THE ORGANS OF HEARING.

The ear is composed of three parts. 1. The *external ear*. 2. The *middle ear*, or *tympanum*. 3. The *internal ear*, or *labyrinth*.

The EXTERNAL EAR consists of two portions, the *pinna* and *meatus*.

The AUDITORIUS PINNA is a kind of funnel, which collects the vibrations of the atmosphere, which vibrations are called sounds.

The MEATUS AUDITORIUS is a canal partly cartilaginous and partly osseous, about an inch in length, which extends

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Why are artisans and scholars generally near-sighted? Why are sailors and hunters long-sighted? How should children be taught to view objects? *Of how many parts is the ear composed?* Of what does the external ear consist? Describe the pinna. The meatus auditorius.

inwards from the pinna to the tympanum. It is narrower in the middle, than at each extremity. It is lined by an extremely thin pouch of cuticle, which, when withdrawn, after maceration, preserves the form of the canal. Some stiff, short hairs are also found in the interior of the channel, which stretch across the tube, and prevent the ingress of insects. Beneath the cuticle are a number of small *ceruminous follicles*, which secrete the wax of the ear. The external ear is plentifully supplied with blood vessels, and nerves from the fifth pair.

Fig. 194.

Fig. 194, Represents the temporal bone in which the organs of hearing are located. 1, The squamous or thin portion of the temporal bone. 2, 2, The petrous portion. 3, The mastoid process behind the ear. 4, The styloid process. 5, The external opening of the meatus auditorius.

The MEMBRANA TYMPANI, or drum of the ear, is a thin semi-transparent membrane, of an oval shape. It is about three-eighths of an inch in diameter. It is inserted into a groove around the circumference of the meatus, near its termination. It is placed obliquely across the area of that tube. It is concave towards the meatus, and convex towards the tympanum. It is composed of three layers, — an external *cuticular;* a middle *fibrous* and *muscular;* and an internal *mucous.*

The MIDDLE EAR consists of an irregular bony cavity, situated within the temporal bone. It is called the *tympanum.*

What are found in the interior surface of this canal, and what is their use? Where are the ceruminous follicles? What does Fig. 194 represent? Describe the membrana tympani, or drum of the ear. Of how many layers is the drum of the ear composed? Describe the tympanum.

It is bounded externally by the membrana tympani; internally by its inner wall; and in its circumference by the petrous bone and mastoid cells.

The tympanum contains four small bones, *ossicula audita*, named separately, the *malleus, incus, stapes*, and *orbicular.*

Fig. 195.

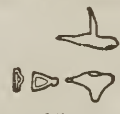

Fig. 195. Represents the *four* bones of the ear. The smallest is represented magnified. This bone is early matured, and in the adult it becomes united with the incus. These bones are retained in their places and moved by three ligaments and four muscles.

There are ten openings into the tympanum or middle ear; five large and five small openings. The larger openings are the *Meatus auditorius, Fenestra ovalis, Fenestra rotunda, Mastoid cells,* and *Eustachian tube.*

Fig. 196.

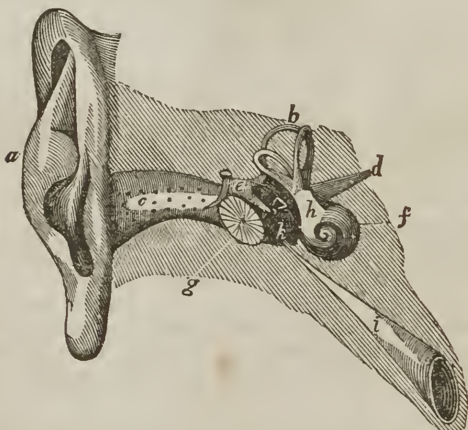


Fig. 196. Represents the pinna, meatus, membrana tympani, ossicula audita, and semicircular canals. *a*, The pinna. *c*, The meatus auditorius. *g*, The membrana tympani. *k*, The tympanum. *e*, The ossicula audita. *b*, the semicircular canals. *f*, The cochlea. *h*, The vestibule. *i*, The Eustachian tube. *d*, the auditory nerve. Let the student describe the external and middle ear from this engraving.

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How many bones are contained in the tympanum? What is said of the orbicular, or smallest bone of the ear? How many openings into the middle ear? Name them. Describe Fig. 196.

The Fenestra ovalis is the opening of communication between the tympanum and the vestibule. It is closed by the foot of the stapes, and by the lining membrane of both cavities.

The Fenestra rotunda serves to establish a communication between the tympanum and the cochlea. It is closed by a proper membrane, as well as by the lining of both cavities.

The Mastoid cells are very numerous, and occupy the whole of the interior of the mastoid process, and part of the petrous bone. They communicate, by a large irregular opening, with the upper and posterior circumference of the tympanum.

The Eustachian tube is a canal of communication, extending obliquely between the pharynx and the anterior circumference of the tympanum. In structure it is partly fibro-cartilaginous and partly bony. It is broad and expanded at its pharyngeal extremity, and narrow and compressed at the tympanum.

The small openings are, 1, For the entrance of the chorda tympani. 2, For the exit of the chorda tympani. 3, 4, and 5, For the exit of the muscles that act upon the membrana tympani and bones of the ear.

The INTERNAL EAR is called the *labyrinth*, from the complexity of its communications. It consists of a membranous and a bony portion. The bony labyrinth presents a series of cavities which are channeled through the substance of the petrous bone. It is situated between the cavity of the tympanum and the meatus auditorius internus. It is divisible into the *vestibule*, *semicircular canals*, and *cochlea.*

The VESTIBULE is a small, three-cornered cavity, situated immediately within the inner wall of the labyrinth. The three corners, which are named ventricles or cornua, are placed, one anteriorly, one superiorly, and one posteriorly.

The openings of the vestibule may be arranged into large and small. The large openings are seven in number, viz. the *Fenestra ovalis*, *Scala vestibule*, and five openings of the three *semicircular canals.*

The Fenestra ovalis is the opening into the tympanum.

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Describe the fenestra ovalis. The fenestra rotunda. The mastoid cells. The Eustachian tube. Why is the internal ear called the labyrinth? Describe the bony labyrinth. Where is it situated? How is it divided? Describe the vestibule.

The Scala vestibule is the oval termination of the vestibular canal of the cochlea.

The SEMICIRCULAR CANALS are three bony passages which communicate with the vestibule, into which two open at both extremities, and the third at one extremity.

The COCHLEA, so called from its resemblance to a snail shell, forms the anterior portion of the labyrinth. It consists of a bony and gradually tapering canal, about one and a half inches in length, which makes two turns and a half, spirally, around a central axis, called the *modiolus*. The modiolus is large near its base, where it corresponds with the first turn of the cochlea, and diminishes in diameter towards its extremity.

Fig. 197.

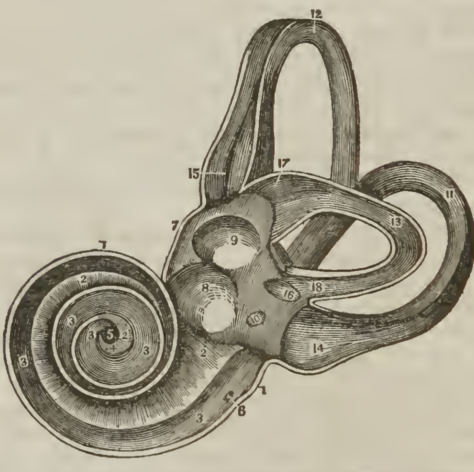


Fig. 197. A view of the labyrinth of the left ear, laid open in its whole extent, so as to show its structure. This figure is highly magnified.
1, 1, The thickness of the outer covering of the cochlea. 2, 2, 2, The scala vestibuli, or upper layer of the lamina spiralis. 3, 3, 3, 3, 3, The scala tympani, or lower layer of the lamina spiralis. 4, The hamulus cochleæ. 5, The centre of the infundibulum. 6, The foramen rotundum, communicating with the tympanum. 7, The thickness of the outer layer of the vestibule. 8, The foramen rotundum. 9. The fenestra ovalis. 10, The orifice of the aqueduct of the vestibule. 11, The inferior semicircular canal. 12, The superior semicircular canal. 13, The external semicircular canal. 14, The ampulla of the inferior canal. 15, The ampulla of the superior canal. 16, The common orifice of the superior and inferior canals. 17, The ampulla of the external canal.

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What are the semicircular canals? Why was the name cochlea given to the anterior portion of the labyrinth? Of what does it consist? Describe Fig. 197.

The interior of the canal of the cochlea is divided into two passages, by means of a bony and membranous lamina, called the lamina spiral. These two passages are called the small *scalæ.* At the extremity of the modiolus, the two scalæ communicate with each other. At the other extremity, one opens into the vestibule; the other into the tympanum, by the foramen rotundum.

The internal surface of the bony labyrinth is lined by a fibro-serous membrane.

The membranous labyrinth is smaller in size, but a perfect counterpart, with respect to form, of the bony vestibule, and semicircular canals. It consists of two small, elongated sacs, one named the *sacculus communis;* and the other, the *sacculus proprius.* The membranous labyrinth is filled with a limpid fluid, first described by Scarpa,—thence named the liquor Scarpæ.

The AUDITORY NERVE divides into two branches, at the bottom of the *cul de sac*, or cavity of the meatus auditorius internus,—a vestibular and a cochlear nerve.

Fig. 198.

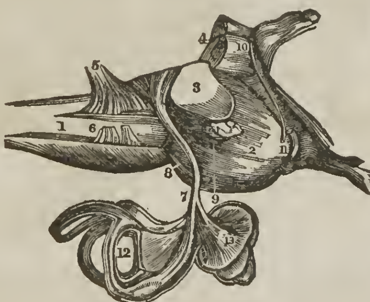


Fig. 198. A view of the origin and distribution of the portio mollis of the seventh pair, or auditory nerve. 1, The medulla oblongata. 2, The pons varolii. 3, 4, The crura cerebelli of the right side. 5, The eighth pair of nerves. 6, The ninth pair. 7, The auditory nerve, seen dividing into two branches, one of which is distributed in the vestibule and semicircular canals (12) and the other in the cochlea (13.) 8, The sixth pair of nerves. 9, The facial nerve of the seventh pair. 10, The fourth pair. 11, The fifth pair.

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How is the interior of the cochlea divided? With what is the internal surface of the bony labyrinth lined? What is said of the membranous labyrinth. Where do the vestibular and cochlear nerves originate? What does Fig 198 exhibit?

The two branches of the auditory nerve enter the structure of the *sacculi*, and *membranous labyrinth*, radiating in all directions, anastomosing with each other, forming interlacements and loops. They terminate upon the inner surface of the membrane, in minute papillæ, resembling those of the retina.

## PHYSIOLOGY OF THE EAR.

In audition, or hearing, all the organs that have been described are called into action. If any part of them be wanting or defective, hearing will be more or less impaired.

Fig. 199.

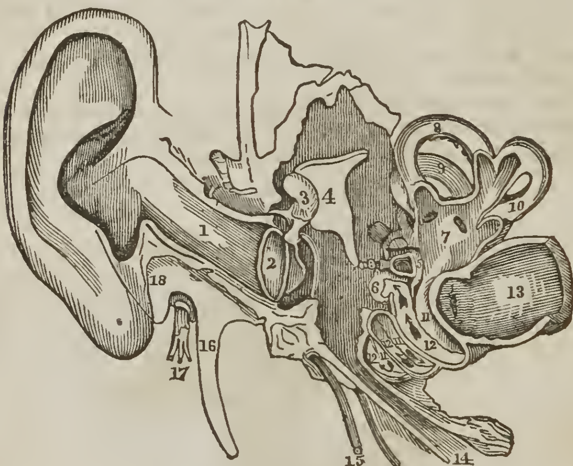


Fig. 199. A view of all parts of the ear. 1, The meatus auditorius. 2, The membrana tympani. 3, The malleus bone. 4, The incus bone. 5, The stapes, which is placed in the foramen ovalis, an opening into the vestibule (7.) 6, The foramen rotundum. 8, 9, 10, The semicircular canals that open into the vestibule, (7.) 11, 11, 11, The scala, or canal of the cochlea, that opens into the vestibule of the internal ear. 12, 12, 12, The scala or canal of the cochlea that connects with the middle ear, through the foramen rotundum, 6. 13, The meatus auditorius internus. 14, The Eustachian tube. 15, The chorda tympani. 16, The styloid process of the temporal bone. 17, The portio dura of the seventh pair of nerves. 18, The mastoid process.
1, 2, Are parts of the external ear. 3, 4, 5, The small bones placed in the middle ear. 7, 8, 9, 10, 11, 12, 13, Are parts of the internal ear.

With Fig. 199 before the pupil, let him describe the different parts of the ear, and their agency in hearing.

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Describe the course of these nerves. What is the effect if any organ of the ear be defective? Describe Fig. 199.

A certain influence, not well understood, called *sound*, ope rating generally through the medium of the air, which is compared to waves or vibrations, is collected by the external ear, and conducted into the meatus auditorius, (1.) This strikes upon and puts in vibration or motion the membrana tympani, or drum of the ear, (2.) The vibration of the membrana tympani is communicated to the malleus, (3,) that lies in contact with it. The bone (3) is bound to the bone (4.) The bone (4) to the bone (5.) The bone (5) communicates with the vestibule of the internal ear, (7.) The vibration is conveyed from the drum of the ear to the fossa of the internal ear, by the chain of bones and the air in the middle ear. The vibration which is communicated to the fluid of the labyrinth, is thus impressed upon the delicate expansion of the auditory nerve, which transmits it to the brain.

If the meatus (1) be closed, hearing will be destroyed. If the membrana tympani is thickened by viscid wax, its vibration will be diminished and hearing impaired. If the bones (3, 4, 5,) are removed, impaired hearing follows, as sound is not communicated freely from the membrana tympani to the vestibule of the internal ear. If the Eustachian tube be obliterated by inflammation of the throat, the vibrations of air in the inner ear will be diminished, and defective hearing follows. Disease, or destruction of the labyrinth, or auditory nerve, will impair and destroy the sense of hearing. Deafness may result from any or all of the above causes.

## PRACTICAL SUGGESTIONS.

Like all our other senses, hearing is capable of very great improvement by cultivation, and, acute audition requires perfection in the structure and functions of the different parts of the ear, and that portion of the brain from which the auditory nerve proceeds. Defective hearing is by no means unfrequent. To some of the common causes of imperfect hearing we now invite the reader's attention.

1. The structure or functional action of the brain may be deranged by inflammation, by compression, or by debility.

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Describe how sound is communicated through the apparatus of the ear to the brain. State some of the causes of deafness. Can hearing be improved by cultivation? What is necessary to acute hearing? Name one cause of defective hearing.

The first is seen during inflammatory affections of the brain, and in fevers; the second is seen in accidental injuries of the head; the third is seen in old age, and after severe diseases of the head and fevers. In these cases, applications to and operations upon the ear do no good. The only remedy is to remove, if possible, the diseased condition of the brain.

2. Imperfect hearing may be produced by the destruction of the membrana tympani, or removal of the ossicula audita, or the parts within the labyrinth. In these instances, medical treatment is of no avail, as the destroyed parts cannot be restored.*

3. Hearing may be rendered defective, by a diminution of the vibratory character of the membrana tympani. This may result from thickening of this membrane, or from accumulation of wax upon its outer surface. The increased thickness is usually the result of inflammation, either acute or chronic. The proper treatment is such as is efficient to remove inflammatory action. The introduction of heads of pins into the ear, is a frequent cause of chronic inflammation of the membrana tympani. Hence, this practice should never be adopted, and if acquired, should be abandoned. The accumulations of viscid wax may be softened by dropping some animal oil into the ear, and then removing it by injecting warm soap suds into the ear a few hours subsequent to the use of the oil.

* "There are some diseases familiar to medical gentlemen, beside local affections of the ear, which fix upon the bones about the face. Under such circumstances, a sanious discharge washes these little bones entirely away. Nothing is more certain than the fact, that the three first bones may be corroded and floated from their connections: indeed, extracted with forceps, and the patient hear, to all intents and purposes, nearly, if not quite as well as he did before. Thus the membrane, (drum-head,) and three out of four bones are unnecessary, it seems, in the auditory apparatus of man. Stripped thus, it falls below the frog's, being deficient in an external covering, or vibrating membrane. The vibrations, in this case, act directly on the foot-piece of the stapes, which is broad enough to offer resistance to the vibrating air. Being connected with the membrane of the *fenestra ovalis*, it produces a motion in it, which is propagated to the fluid beyond, and thus the nerve becomes agitated. If the stapes could be detached without rupturing the membrane of the fenestra ovalis, then hearing could be effected independent of the little bones. Their use is merely to strengthen the vibrations within, just in the proportion that they have a tendency to become faint as the distance increases whence they had their origin."

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Name another cause of defective hearing. What is the third cause? What is said of the introduction of pins to cleanse the ear? What is the remedy where there is an accumulation of wax?

4. Hearing may be impaired by obstruction of the Eustachian tube. The closure of this canal diminishes the vibratory character of the air within the tympanum, in the same manner as closing the opening in the side of a drum. Hearing is as much impaired by closing the Eustachian opening, as the tones of a drum are by obstructing the side apertures. And for the same reason, enlarged tonsils, inflammation and ulceration of the fauces and nasal passages, during and subsequent to scarlet fever, and the inflammation attending the *sore throat* in common colds, are common causes of this obstruction. The treatment of such cases of defective hearing, is to have the tonsils, if enlarged, removed by a surgeon; the inflammation and thickening of the parts removed by remedial means directed by a skilful physician. A large proportion of the cases of defective hearing among young and middle-aged persons, are caused by obstruction of the Eustachian tube, and can be relieved by the application of proper means.

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Name the fourth condition by which hearing is impaired. Why does the closing of this canal affect the hearing? What is the treatment where there are enlargements or ulcerations in the throat?

# CHAPTER XII.

## ABSORPTION, SECRETION, NUTRITION, AND ANIMAL HEAT.

ABSORPTION is a process by which food and drinks, designed for the growth and nourishment of the body, are imbibed and carried into the system. Those particles and materials that have been already deposited, and have become injurious or useless, are conveyed from the mass of fluids and removed from the system. The absorption necessary for the growth of the human body, is effected by the action of the *lacteals* and *thoracic duct, (described in the chapter upon the Anatomy and Physiology of the Digestive Organs.)* The absorption that removes injurious matter from the human body, is effected by the action of *absorbent vessels* and *lymphatic glands.*

### ANATOMY OF THE ABSORBENT VESSELS AND GLANDS.

These vessels arise not only from the surface of the skin and mucous membranes, the cavities of the chest, abdomen, pericardium, and joints, but also from the ventricles of the brain. They are extremely minute at their origin, so that in many parts they cannot be detected without the aid of a microscope. As they proceed, they unite and form larger trunks, which open into the large veins near the heart.

The walls of these vessels have two coats, of which the external one is cellular, and is capable of considerable distension. The internal coat is folded so as to form valves, like those in the veins. Their walls are so thin, that these folds give them the appearance of being knotted. At certain points the absorbent vessels pass through distinct, soft bodies, peculiar to themselves, which are called *lymphatic glands.* These

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*Define absorption.* By what vessels is the absorption necessary for the growth of the system effected? Those that remove injurious matter from the system? Where do the absorbent vessels arise? Describe these vessels. How many coats have they? What of the external coat? The internal? Have the absorbent vessels glands?

glands vary in form and in size. They are extremely vascular, and appear to consist of a collection of minute vessels. Lymphatic glands are found in different parts of the body, but they are most abundant in the groins, axilla, or arm-pits, neck, and cavities of the thorax and abdomen.

Fig. 200. Fig. 201. Fig. 202.

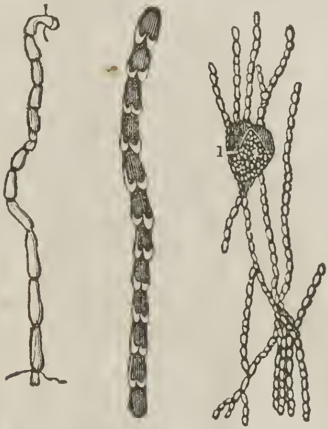


Fig. 200. Represents a single absorbent vessel, much magnified.
Fig. 201. Represents the valves of a lymphatic trunk.
Fig. 202. Represents several absorbent vessels passing through a lymphatic gland, 1.

The coats of the absorbents are supplied with nutrient arteries, veins, and ganglionic nerves.

## PHYSIOLOGY OF THE ABSORBENTS.

Many experiments have proved that the skin may absorb sufficient nutrition to support life for a time, by immersing the patient in a bath of milk or broth. Thirst may be quenched by applying moist clothes to the skin, or by bathing. It is no uncommon occurrence, during a passage from one continent to the other, for the saliva to become bitter by the absorption

Describe the lymphatic glands. Where are they most abundant? Do these vessels inosculate? With what are the coats of the absorbents supplied? May life be supported by absorption through the skin?

Fig. 203.

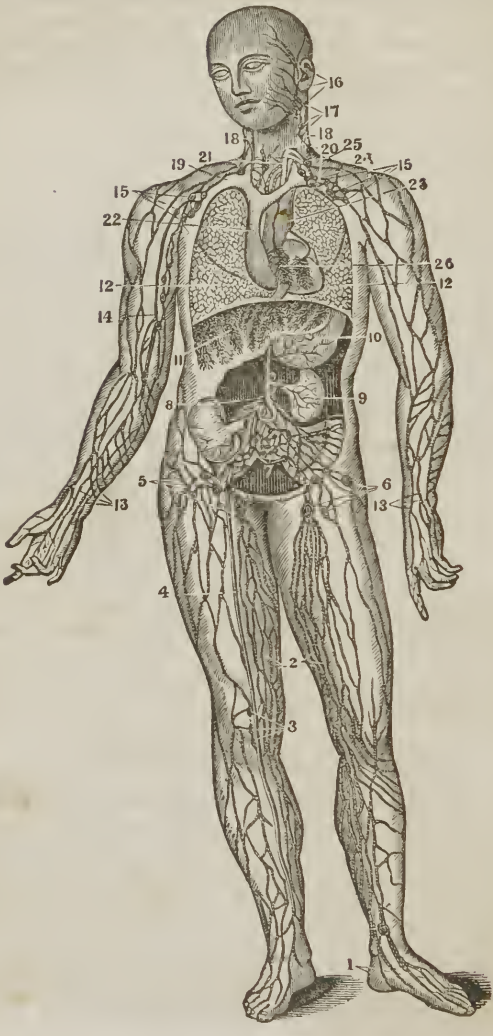
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Fig. 203. A representation of the absorbent vessels and glands. 1, Absorbents upon the foot. 2, Absorbents upon the leg. 3, Absorbent glands about the knee. 4, The saphena vein. 5, The superficial absorbent glands of the groin. 6, The deep-seated glands of the groin. 7, Lymphatic glands in the tract of the iliac arteries and veins. 8, The commencement of the thoracic duct, into which the absorbents of the lower extremities and intestines open. 9, The kidney, with its absorbents. 10, The stomach, and its absorbents. 11, The liver, with its absorbent vessels. 12, 12, The lungs. 13, 13. The superficial absorbents of the arm. 14, The superficial brachial vein. 15, 15, Glands through which the absorbents of the arm pass. 16, Absorbents of the face. 17, Lymphatic glands through which the absorbents of the head and neck pass. 18, 18, The jugular veins. 19, The right subclavian vein. 24, The left subclavian vein. 22, The descending vena cava. 23, The aorta. 21, The thoracic duct. 25, The point where it opens into the vein at the junction of the left subclavian and left jugular veins. 26, The heart and its absorbents. The materials imbibed by the absorbents of the different parts of the system are conveyed into the veins at the point (25.)

of sea water. It has been found that the hand, immersed to the wrist in warm water, will absorb from ninety to one hundred grains of fluid in the space of an hour. Medicinal substances, such as mercury, morphine, and Spanish flies, are frequently introduced into the system through the skin.

The alimentary canal is supplied not only with lacteals, but also with lymphatic vessels. These, and the venous radicles, absorb fluids brought in contact with them, as water, alcohol, &c.

The mucous membrane of the lungs is abundantly supplied with absorbents. By their action, substances finely pulverized, or in the form of gas, are readily imbibed when inhaled into the lungs, such as metallic vapors, odoriferous particles, *tobacco smoke*, marsh, and other effluvia. In this way contagious diseases are frequently contracted.

Physiologists have given to absorption different names, according to the different functions which the vessels perform. *Interstitial* absorption is that change of the particles of matter of which every organ is composed, that is constantly going on in the animal economy. The action of these vessels counterbalances those of nutrition, and thus the form and size of every part of the body is preserved. When their action exceeds that of the nutrient vessels, the body emaciates; when it is deficient, plethora is the result. In youth, they are less active than the nutrient vessels, but in later periods of life we find these actions reversed, and the body diminishes in

How much fluid will the hand immersed to the wrist absorb in an hour? How are medicinal substances frequently introduced into the system? With what vessels is the alimentary canal supplied? Are absorbents found in the mucous membranes? Are diseases ever contracted by inhaling vapors and gases? How? What is interstitial absorption? What is said of these and the nutrient vessels? Which is the most active in youth? In old age?

size. It is not unfrequent that tumors of considerable size disappear, and even the entire bone of a limb has been removed from the same general cause.

*Recrementitial* absorption is the removal of those fluids from the system, which are secreted upon surfaces that have no external outlet. These fluids are various, as the fat, the marrow, the synovia of joints, serous fluids, and the humors of the eye. Were it not for this variety of absorption, dropsy would generally exist in the cavities of the brain, chest, and abdomen, from the continued action of the secretory vessels.

*Excrementitial* absorption relates to the fluids which have been excreted, such as the bile, pancreatic fluid, saliva, milk, and other secretions. *Cutaneous* absorption relates to the skin; *respiratory*, to the lungs.

All these varieties of absorption are maintained through life, except when suspended by disease.

## ANATOMY OF THE SECRETORY ORGANS.

There are three kinds of secretory organs, viz: the *exhalent vessels*, the *follicles*, and the *glands*.

The EXHALENTS are supposed to be terminations of the arteries, or capillaries. They are of two kinds, external and internal. The latter terminate on the surfaces within the body, and the former upon the outside.

Fig. 204.

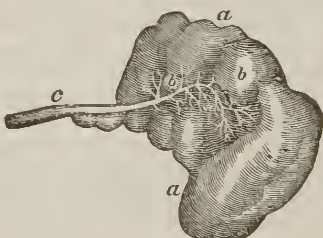


Fig. 204. *a*, *a*, Represents a secretory gland. *b*, *b*, Minute ducts that are spread through the glands. These coalesce to form the main duct, *c*.

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What is recrementitial absorption? What is excrementitial absorption? Are these varieties of absorption maintainable through life? Name some of the changes which absorption produces. *Name the secretory organs.* What are the exhalents supposed to be? How many kinds of exhalent vessels?

The FOLLICLES are small bags or sacs, in the true skin and mucous membranes. The pores seen on the skin are the outlets of these follicles. These sacs are supplied with veins and organic nerves.

The GLANDS are the chief agents of secretion in the body. They are of various sizes, and generally of a rounded form. Every gland is supplied with arteries, veins, lymphatics, and nerves, arranged in a peculiar manner, and connected together by cellular membrane.

Fig. 205.

**Fig. 205. Represents an artery and its ramifications in a secretory gland.**

## PHYSIOLOGY OF THE SECRETORY ORGANS.

Secretion is one of the most obscure and mysterious functions of the animal economy. To *secrete* means to *separate.* Most of the fluids formed by this process did not previously exist in the blood, but only the elements out of which they were made. It is purely a *vital*, and not a *chemical* or *mechanical* process. The vessels by which it is accomplished may well be called the architects and chemists of the system; for out of the same material — the blood — they construct a variety of wonderful fabrics and chemical compounds.

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Where are the follicles found? What are the chief agents of secretion in the animal economy? With what is each gland supplied? Design of Fig. 205? Define secretion. What kind of process is it?

We see the same wonderful power possessed also by vegetables; for out of the same materials the olive prepares its oil, the cocoa-nut its milk, the cane its sugar, the poppy its narcotic, the oak its green pulpy leaves, its light pith, and its dense woody fibre. All are composed of the same, few, simple elements, arranged in different order and proportions.

In like manner, we find the vessels, in animal bodies, capable of forming all the various textures and substances which make up the frame; the cellular tissue, the membranes, the ligaments, the cartilages, the bones, the marrow, the muscles with their tendons, the lubricating fluid of the joints, the pulp of the brain, the transparent jelly of the eye; in short, all the textures of the various organs of which the body is composed, consist of similar ultimate elements, and are manufactured from the blood.

The proof that secretion is a *vital* process, is, that it is so much influenced by the nervous system. It is no uncommon occurrence, that the nature of milk will be so changed from the influence of anger in the mother, as to cause vomiting, colic, and even convulsions, in the infant that swallows it. Sudden intelligence of the loss of friends or property, by its influence on the vital nerves, will destroy the appetite. Some mental agitation, as fear, will cause a cold sweat to pervade the surface of the body.

Let the nerves which are distributed to any organ be divided, and the function of secretion will be suspended. The changeful states of the nervous system is undoubtedly the cause that the secretions vary so much in quality as well as quantity, at different periods.

All the blood distributed to the different glands, is similar in composition and character; but the fluids secreted by them, vary in appearance in a remakable degree. The yellow, ropy fluid, called bile, the insipid saliva, and the saline tears, are products of different secretory glands.

*Fat* is a secretion, which is thrown out, in a fluid state, from the cellular membrane. It is deposited in little cells, and exists in the greatest abundance between the skin and the muscles. It forms a cushion around the body, and thus

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Have vegetables the same property of secretion? Illustrate this. Do the textures of the various organs consist of similar elements? Made from what? What proof that it is a vital process? Are the products of secretion similar throughout the different glands? What is fat? What is its use?

protects it from external injuries, as well as the extremes of heat and cold.

When little or no food is taken into the stomach, life is supported by the absorbent vessels imbibing the fat and reconveying it into the circulatory system. It is the removal of this secretion which causes the sunken cheek and hollow eye, in a person recovering from a fever. In consumption, the extreme attenuation of the limbs is caused by the absorption not only of the fat, but also of the muscles and more solid parts of the system. Animals which lie in a half torpid state during the winter, derive their nourishment from the same source.

The *marrow* in the cavities of the long bones, is very much like fat. This is a secretion from a thin delicate membrane, that lines the cavities of the bones. These are the principal internal exhalations or secretions.

There are two external secretions, viz., one from the skin, called perspiration, and the other from the lungs. (See *Chapter upon the Skin.*) The secretion from the lungs is similar to that of the skin.

When any substance which is not demanded for nutrition, or does not give nourishment to the system, is imbibed by the absorbent vessels and conveyed into the blood, it is eliminated by secretions. A few years since, a poor inebriate was carried to a London hospital in a state of intoxication. He lived but a few hours. On examining his brain, nearly half a gill of fluid, strongly impregnated with *gin*, was found in the ventricles of the brain. This was secreted from the vessels of the brain.

Unless the secretions are regularly maintained, disease will be the ultimate result. Let the secretions from the skin be suppressed, and fever, or some internal inflammation will follow. If the bile be impeded, digestion will be impaired. If any other secretion be suppressed, it will cause a disarrangement in the various internal organs. Ardent spirits derange the secretions, and change the structure of the brain. This is one reason why inebriates do not live to advanced age.

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How is the system maintained in fevers? Why the emaciation in consumption? What is marrow? Relate the incident at the London Hospital a few years since. Can health be maintained if the secretions be suppressed? What is one reason why alcohol shortens life?

## NUTRITION.

"NUTRITION is that process by which the waste of organs is repaired, and by which their development and growth are maintained. Respiration, digestion, circulation, absorption, and secretion, are but separate links in the chain of nutrition, which would be instantly destroyed by the absence of any one of them.

"In the construction of a machine, or an instrument designed to last for many years, the mechanist seeks for the most durable materials. In making a watch, for instance, he forms the wheels of *brass*, the spring and barrel-chain of *steel*, and for the pivot, which is subject to incessant friction, he employs the hardest of all materials,—*the diamond.* The necessity for this arises from the fact, that such instruments do not contain, within themselves, the power of repairing their own losses.

"But far different is the case with the *animal machine.* In order to qualify it for exercising the functions of life, it must be so constructed as to render it capable of continual alterations, displacements, and adjustments; and these subject to continual variation, according to the stage of growth, and also to the different circumstances in which it may be placed. Instead, therefore, of a few elementary bodies, or their simpler combinations, nature has employed such compounds as admit of greater change, and a more variable proportion of ingredients, and greater diversity in the mode of combination. It is nutrition that moulds these materials, and forms these ever-changing compounds, and so preserves the animal machine amid the varying changes of condition to which it is subject."

The ever-changing state of the system, is shown by giving animals colored matter, mixed with their food, which in a short time tinges their bones with the same color as the matter introduced. Let it be withdrawn, and in a few days the bones will assume their former color — evidently from the effects of absorption. The changeful state of the body is further shown, by the losses to which it is subjected; by the necessity of aliment; by the emaciation which follows abstinence from food.

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*What is nutrition?* By what function is the system maintained in its ever-changing state? Give some proofs of the constant change in the system.

Every part of the body is subject to this constant change of material. While the absorbents are removing the decayed atoms of matter from the system, the capillaries are repairing the loss, by depositing bone, muscle, cartilage, nerve, tendon, fat, ligament, membrane, hair, and nails. These changes are effected with such regularity, that the size, shape and appearance of every organ is preserved; and yet, after an interval of a few years, there may not remain a particle of matter which existed in the system at a former period. Notwithstanding this entire change, the personal identity is never lost.

"Those animals which are most complicated in their structure, and are distinguished by the greatest variety of vital manifestations, are subject to the most rapid changes of matter. Such animals require more frequent and more abundant supplies of food, and in proportion as they are exposed to the greater number of external impressions, will be the rapidity of this change of matter.

"Animals may be situated so that they lose nothing by secretion or evaporation; consequently, they will require no nutriment. *Frogs* have been taken from fissures in solid lime rock, which were imbedded many feet below the surface of the earth, and on being exposed to the air, exhibited signs of life. How the vital principle was preserved, when they had remained there perhaps for centuries, is not easily explained.

"The *blood* contains all the materials of nutrition. The process by which the food is changed into blood, has been already explained. As it goes the round of the circulation, the nutrient, capillary vessels select and secrete those parts which are similar to the nature of the structure, and the other portions pass on; so that every tissue imbibes and converts to its own use, the very principles which it requires for its growth; or, in other words, as the vital current approaches each organ, the particles appropriate to it feel its attractive force, — obey it, — quit the stream, — mingle with the substance of its tissue, — and are changed into its own true and proper nature."

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Why does not a person lose his identity in the exchange of materials? What animals are subject to the greatest changes of matter? What is related of frogs? What contains the materials of nutrition?

Thus, if a bone be broken, or a muscle or a nerve be wounded, and if the system be in a proper state of health, the vital economy immediately sets about healing the breach. The blood, which flows from the wounded vessels, coagulates in the breach, for the double purpose of stanching the wound, and of forming a matrix for the regeneration of the parts. Very soon, minute vessels shoot out from the living parts into the coagulum of the blood, and immediately commence their operations, and deposit bony matter, where it is required to unite fractured bones, and nervous substance to heal the wounded nerve, &c. But the vital economy seems not to possess the power of reproducing the true muscles, and therefore, when any fleshy part has been wounded, its breach is repaired by a gelatinous substance, which gradually becomes hard, and sometimes assumes something of a fibrous appearance. It however so perfectly unites the divided muscle, as to restore its functional power.

Before the body has attained its full growth, the function of nutrition is very active; a large amount of food is taken, to supply the place of what is lost by the action of the absorbents, and also to contribute to the growth of the body. In middle age, nutrition and absorption are more equal; but in old age, the absorbents are more active than the nutrient vessels. The size, consequently, diminishes, the parts grow weaker, the bones more brittle, the body bends forward, and every function exhibits marks of decay and dissolution.

A striking instance of active absorption in middle age, was exhibited in the person of Calvin Edson, of Vermont, who was exhibited in the large towns of New England, as the "living skeleton." In early manhood he was athletic, and weighed one hundred and sixty pounds; but the excessive action of the absorbents over the nutrient vessels, reduced his weight, in the interval of eighteen years, to sixty pounds.

Instances, on the other hand, have occurred of the action of the nutrient vessels exceeding, in an extreme degree, those of absorption; as in the person of a colored girl, thirteen years of age, who was exhibited in New York, in the summer of 1840.

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When a bone is broken, by what process is it healed? Point out the manner in which it is accomplished. What occurs when a muscle is divided? When is nutrition most active? How in middle age? How in old age? Relate a striking instance of active absorption in middle age? Of excessive nutrition in early life.

She was of the height of misses at that age, but weighed five hundred pounds! Several cases are on record of men weighing eight hundred pounds.

## ANIMAL HEAT.

The true sources of animal heat, or calorification, in animal bodies are yet imperfectly known; and it is doubtful whether we shall ever be able to penetrate the veil which conceals the wonderful operations of vital chemistry. Why the temperature of the body is maintained at an average of ninety-eight degrees, and this, too, under all climates and seasons, has eluded the researches of all physiologists.

Various theories have existed. It was once believed that the heart was the great furnace of the system, and that the chief office of respiration was to *cool* the blood. The hypothesis of Mr. Black was, that respiration is a kind of combustion, by which all the heat of the body is generated. If this be strictly true, the heat of the lungs should be much greater than that of the other parts of the system.

It is found, by experiment, that arterial blood is warmer than venous. The blood acquires about one degree of heat in passing through the lungs. If the blood pass through the lungs twenty times an hour, the system will receive from respiration twenty degrees of heat, or two hundred and forty degrees every twelve hours. Mr. Brodie's hypothesis was, that animal heat depends on, or is produced by, nervous influence. He showed by some experiments, that in decapitated animals, the temperature fell more rapidly when respiration was sustained artificially, than when it was not.

Another class of physiologists maintain, that animal heat is generated in the capillary system. This theory receives some support from the fact, that there is some increase of heat in the part, when a portion of the system is irritated or inflamed. But, in order to the production of animal heat by the action of the capillary vessels, two conditions are necessary. One is the presence of arterial blood, the other the action of the

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*Are the sources of animal heat known?* What is the average temperature of the body? What was one theory in regard to the source of animal heat? What was Mr. Black's hypothesis? Which has most heat, arterial or venous blood? How much is the temperature of the blood increased in passing through the lungs? How much heat will the system receive in an hour, allowing twenty respirations each minute? In twelve hours? What is the supposition of Mr. Brodie? What is another theory?

nervous system. That arterial blood is necessary, is shown by the operation of tying the vessels which supply a limb with blood. The consequence always is, that the temperature immediately falls, and such limbs have to be wrapped in cotton, and other means used to preserve a comfortable degree of warmth. That nervous influence is also productive of animal heat, is shown by dividing, in like manner, the nerves which go to any part. The temperature of a paralytic limb is always lower than that of the sound one.

Observation and experiment show, that heat is produced by an action among the molecules, or atoms of the system. In respiration, carbon passes from the system, and oxygen is received. This change of matter is attended by a change of temperature. In nutrition, fluids are converted into solids; in absorption, solids are changed into fluids; in secretion, compounds are decomposed, and new ones formed; in digestion, food is changed into the fluid chyle. In all these processes animal heat is generated. All of these changes are effected in the capillary vessels, and all require a certain amount of pure blood and nervous fluid. It may be concluded, then, that respiration, circulation, and nervous influence, all co-operate in producing animal heat, or that they are conditions essential to this phenomenon.

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What do observation and experiment show? What functions co-operate in the production of animal heat?

# APPENDIX.

THE subject of this Appendix is the practical treatment of *Burns*, *Scalds*, *Wounds*, *Poisons*, and other accidents, which are daily occurring in the community. To meet such exigencies we require information and premeditation. Boys and girls should be so instructed, that they can render assistance to persons suffering from accidents, as well as persons of mature years. In most of these every day occurrences, much pain, and even death may be prevented, by the prompt and proper assistance of some individual who may be present, before a surgeon or physician can be called.

### BURNS AND SCALDS.

When a certain degree of heat is applied to the skin, the action of its vessels will be more or less changed. This is seen under these conditions:—

1. When the nerves are simply irritated, and the blood-vessels distended with blood, attended with severe smarting pain, applications should be applied, to prevent blistering; as blisters are produced by an increased action of the arteries of the skin, which action deposits serum under the cuticle. If this state of the arteries be prevented or suppressed, vesication will not follow. To prevent or suppress this state of arterial action, wet some folds of cotton or woollen cloth with cold water, and apply them to the parts scalded; continue to apply cold water, so as to steadily maintain the low temperature of the applications, as long as the *smarting pain* is experienced.

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Should young persons, as well as of those mature years, be taught how to render proper assistance when a person is burned, or in other accidents of almost daily occurrence? *What is the effect when a certain degree of heat is applied to the skin?* Mention the first condition. How are blisters produced? How can vesication be prevented?

The steady application of cold dressing tends to prevent an increased action of the blood-vessels, and will suppress it, if it already exist.

2. When blisters are formed, the cuticle is separated from the other tissues of the skin by the effusion of serum. In all cases, if the cuticle be not removed, a small opening should be made in the raised cuticle by which the serum deposited may be removed. Under such circumstances, never remove the cuticle, as it makes the best possible covering for the blood-vessels and nerves of the true skin. The cold water dressing, recommended above, may then be applied as long as the smarting continues. After the pain has subsided, the blistered part may be covered by a patch of cotton or linen cloth, upon which a cerate or ointment, made of lard and bees-wax has been spread.

3. If the cuticle has been removed, there will be much suffering, because the nerves are unduly stimulated by the air. The cuticle is the sheath or covering of the vessels and nerves of the skin; when it is removed, a substitute should be applied. This substitute should be soothing, and cover the denuded surface. Linseed-meal or ground slippery-elm bark poultice, would make a good dressing; so would fresh cream, or lard and bees-wax, spread upon linen or cotton cloth. When dressings are applied, they should not be removed until they become dry and irritating. If there be much suffering, administer to an adult from twenty-five to sixty drops of laudanum, according to the severity of the pain. If the patient be a child, from fifteen drops to a tea-spoonful of paregoric may be administered. When there is much prostration, some hot peppermint tea, a little hot wine, or brandy and water, may be found necessary to bring on reaction.

### FROST-BITE, OR FREEZING.

The hands, feet, ears, &c., are subject, in cold latitudes, to be frozen or frost-bitten. This may occur when the patient, at the moment, is not aware of it. The part affected at first assumes a dull red color, which gradually gives place to a pale, waxy appearance, and becomes quite insensible.

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What should be the treatment when blisters are formed? What should be the treatment if the cuticle has been removed? How often should the dressing of burns be removed? *What is the appearance of limbs while freezing?*

The first thing to be done in such cases, is to re-establish circulation. This may be accomplished by rubbing the frozen limb with snow, or when this is not to be obtained, cold water; but the snow is always to be preferred. The fire should be avoided; and it would be better for the patient to be kept in a cold room, for a time, where there is no fire, or where the temperature is moderate.

A person may be found by the road side, benumbed with the cold, and be almost or quite insensible. Such a person should be taken into a cold room, the clothing removed, and friction commenced, and continued for some time, with *snow*. When warmth begins to be restored, the individual should be rubbed with dry flannel, and the friction continued, until re-action takes place. As soon as the patient is sufficiently revived to be able to swallow, give a little warm drink, as ginger-tea, or weak wine and water. The patient should then be placed in a cold bed. The after-treatment should be conducted by a surgeon. If the frozen parts are followed by blisters, treat them as directed in the section on burns.

## ASPHYXIA, FROM DROWNING.

As cases of drowning are frequent, and the recovery of the body often so speedy, life, in many instances, might be restored, if the proper means were resorted to in season. It is very important that every member of the community should be made acquainted with the proper mode of proceeding in such cases. The following directions are given by one of the ablest men connected with the surgical profession in this country.

"Immediately, as soon as the body is removed from the water, press the chest, suddenly and forcibly, downward and backward, and instantly discontinue the pressure. Repeat this without intermission, until a pair of common bellows can be procured; when obtained, introduce the nozzle well upon the base of the tongue. Surround the mouth with a towel or handkerchief, and close it. Direct a bystander to press firmly upon the projecting part of the neck, called Adam's apple, and use the bellows actively.

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How should the circulation be at first re-established? What should be avoided? What treatment should be adopted when warmth begins to be restored? *What efforts should be made to recover suspended animation in drowned persons?* Relate Dr. Mott's directions.

"Then press upon the chest to expel the air from the lungs, to imitate natural breathing. Continue this an hour, at least, unless signs of natural breathing come on. Wrap the body in warm blankets, and place it near the fire, and do every thing to preserve the natural warmth, as well as to impart artificial heat, if possible. Every thing, however, is secondary to inflating the lungs. Send for medical aid immediately. Avoid all frictions until respiration shall be in some degree established.

"VALENTINE MOTT,

*May*, 1844. "*Surgeon-General Am. Shipwrecks Society.*"

As soon as the patient is able to swallow, a little cordial or warm brandy and water, should be cautiously administered. The too common practice of rolling a person laboring under asphyxia from drowning, on a barrel, in salt, or of suspending him by the feet, is not only useless, but inhuman, and should never be practised. Treat the asphyxiated person as above directed, and send immediately for a physician. *Always remember to place the patient in pure air, and admit attendants only into the apartment.*

### ASPHYXIA, FROM HANGING OR STRANGLING.

Persons asphyxiated from this cause, should be treated as follows: — The knot should be untied from the neck, if practicable, instead of being cut, as in the latter act much force is necessary. If very cold, the body should be warmed, as directed in asphyxia from drowning. What is most to be relied on, is artificial respiration, as directed in the section on drowning. Next, the patient should be bled from the foot, or jugular vein; therefore a surgeon should be obtained as soon as possible.

It is the vulgar impression, in many sections of the country, that the law will not allow the removal of the cord from the neck of a body found suspended, unless the coroner be present. It is therefore proper to say, that no such delay is necessary, and that no time should be lost in removing the body.

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What is said of rolling a drowned person on a barrel, &c.? What caution is given? *What treatment is directed in recovering persons asphyxiated from hanging?* What vulgar impression prevails in the community?

### ASPHYXIA, FROM GAS OF CHARCOAL.

Carbonic acid gas is not only produced by burning charcoal, but is evolved from live coals from a wood fire, and being heavier than the air, it settles on the floor of the room; and if there be no open door, or chimney-draft, to take it off, will accumulate, and, rising above the the head of an individual, cause asphyxia, like drowning in water.

An individual laboring under partial or complete asphyxia from this cause, should be treated in the following manner:—Remove the clothing, and place the body in the open air, upon the back, with the head and shoulders a little elevated. The face and chest should be sponged or sprinkled with cold water or cold vinegar and water. Apply friction to the skin, with a rough towel or flesh-brush, and resort to artificial respiration, as directed in case of drowning. All these measures should be resorted to promptly, and, if necessary, continued for several hours.

### COLDS.

The treatment of a simple cold or cough is not properly understood by the matrons in the community, although each may have their "cure-all" or some excellent specific for it. It is, usually, treated in a manner that coincides with the popular adage, "stuff a cold, and starve a fever!" The stuffing is generally accomplished by taking large quantities of food, and hot, stimulating tea; most frequently the latter is taken exclusively. It is true that many have suffered, and recovered, and the treatment, on this account, has been deemed the correct one. It is also true, that many recovered from fever and small-pox sixty years since, when no cold or fresh air was allowed the patients; but, let a physician practise in this pernicious manner at the present time, and his reputation as a practitioner would be destroyed. Success is no proof of the correct management of colds thus treated, any more than it was in the fever and small-pox several years since. In the simple cold, as well as other diseases, it is essential to know its character, that the treatment may be safe and efficacious.

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How is asphyxia, or suspended animation, produced by charcoal? What treatment is recommended? *Is the treatment of simple colds understood?* What is essential to know in a simple cold?

A cold is generally induced by a chill, that produces a contraction of the blood-vessels of the skin; and the waste material, which should be carried from the body by the agency of the exhalent vessels of this membrane, is retained in the system, and a great portion of it is returned to the mucous membrane of the lungs; because it is a law of the animal economy that organs similar in their functions have sympathy with each other.

The waste material, that should have passed through the many outlets of the skin, creates an unusual fullness of the minute vessels that nourish the mucous membrane of the bronchi; this induces an irritation of these vessels, which irritation increases the flow of blood to the nutrient arteries of the lungs. There is, also, a thickening of the lining membrane of the lungs, caused by the repletion of the bronchial vessels of the mucous membrane; this impedes the passage of air through the small bronchial tubes, and consequently the air-vesicles cannot impart a sufficient quantity of oxygen to purify the blood. Blood imperfectly purified does not pass with facility through the lungs. An additional obstacle to the free passage of air into the lungs, is the accumulation of blood in the nutrient and pulmonary vessels.

*Treatment.* — To effect a speedy cure, it is necessary to diminish the amount of fluid in the vessels of the lungs. This can be effected in two ways. 1st. By diminishing the quantity of blood in the system. 2d. By diverting it from the lungs to the skin. The first condition can be easily and safely effected, by abstaining from food, and drinking no more than a gill of fluid in twenty-four hours. As there is a continuous waste from the skin and other organs of the system, the quantity of blood by this procedure will be diminished, and the lungs relieved of the accumulated fluid. The second condition can be accomplished by resorting to the warm or vapor bath. These and the common sweats will invite the blood from the lungs to the skin. By keeping up the action of the skin for a few hours, the lungs will be relieved. In some instances, emetics and cathartics are necessary; mucilages, as gum arabic, or slippery-elm bark, would be good. After the system is relieved, the skin is more impressible to

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How is a cold generally induced? What is the proper treatment of colds? How can a cure be effected? What is the first condition? The second? Give a physiological reason.

cold, and consequently requires careful protection by clothing. In good constitutions, the first method is the best, and generally sufficient without any medicine or sweating.

## MEANS OF TEMPORARILY ARRESTING THE FLOW OF BLOOD. (HEMORRHAGE.)

If any large artery be severed, the blood will be thrown out in jets or jerks, and will be of a bright red color. The effusion may be so great as to endanger life.

Fig. 206.


Fig. 207.

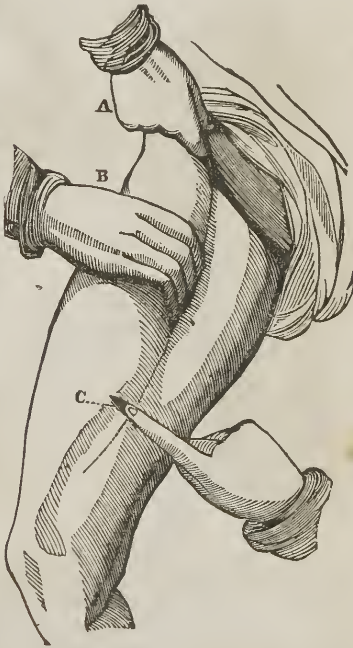


Fig. 206. Represents the track of the femoral artery. 7, The femoral artery where it passes over the pelvic bones. This is the point where compression at the groin is made. (See A, Fig. 207.) 8, The femoral artery at the middle part of the thigh. This is the point where the artery may be compressed with the fingers. (See B, Fig. 207.)

Fig. 207. Represents the different methods of compressing arteries to arrest hemorrhage from divided vessels. A, The method of compressing the femoral artery at the groin, with the thumb, or a compress. B, The method of compressing the femoral

artery below the groin, with the fingers. C, The method of compressing the mouth of the divided artery in the wound, with the fingers. The dotted lines indicate the course of the artery.

When such accidents occur, the person wounded, or some individual who may be present, should arrest the bleeding, by making pressure upon the artery, between the heart and the point of its division, or by using compression directly upon the open mouth of the divided vessel. The best instrument to use in compressing bleeding arteries, is the finger.

Fig. 208.


Fig. 209.


Fig. 208. Represents the track of the axillary and brachial artery. 1, The clavicle, under which lies the subclavian artery. (See Fig. 145.) Under the clavicle, upon the first rib, the artery may be compressed. (See B, Fig. 209.) 9, The axillary artery. 10, The brachial artery. At this point, the artery may be compressed by the fingers. (See A, Fig. 209.)

Fig. 209. B, Represents the method of compressing the subclavian artery upon the first rib under the clavicle. A, The method of compressing the brachial artery with the fingers. C, The method of compressing the divided extremity of an artery in the wound, with the finger.

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How can the flow of blood from divided arteries be arrested? What is the best compress? How is the compression effected? Another method? Describe Figs. 208, 209.

If a person receive a wound in the foot, leg, or thigh, and it bleed profusely, the hemorrhage should be arrested immediately, or life will be sacrificed. This may be done by making forcible compression with three or four fingers of one or both hands, on the upper and inner part of the thigh, over the course of the main femoral artery. Or make compression in the wound, upon the open mouth of the bleeding vessel. This last is the most certain and best means of making pressure to arrest hemorrhage.

If the wound should be in the upper part of the thigh, then compression should be made on the artery where it passes over the bone of the groin. It can easily be found by its pulsation. If the wound should occur in the hand, fore-arm, or arm, the brachial artery may be compressed with three or four fingers, or the subclavian may be compressed above and behind the clavicle, where it passes over the first rib; or, which is preferable, pressure may be made in the wound, upon the mouth of the bleeding vessel.

Fig. 210.

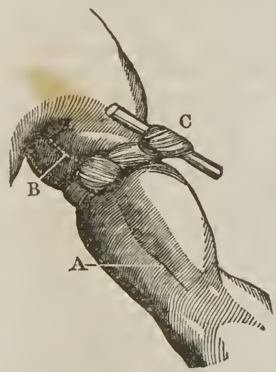


Fig. 211.

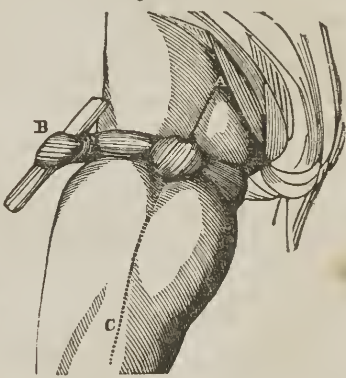


Fig. 210. A, B, The track of the brachial artery. C, The method of applying the knotted handkerchief to make compression on this artery.

Fig. 211. A, C, The track of the femoral artery. (See Fig. 206.) B, The method of applying the knotted handkerchief to make compression on this artery.

After making compression, as before described and illustrated, you should request some person to twist a handker-

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Where should the compression be made, if the wound is in the arm or hand?

chief cornerwise, and tie a hard knot midway between the two ends. This knot should then be placed over the artery, between the wound and the heart, and the two ends carried around the limb, and loosely but firmly tied. A stick, five or six inches long, should then be passed under the handkerchief, which should be twisted by it until the knot has made sufficient compression on the artery to allow the removal of the fingers without a return of the hemorrhage. Continue this compression until the surgeon arrives, who will proceed to put ligatures around the divided and bleeding vessels, or pursue such a course as he may deem proper for the welfare of the patient.

The wound ought not to be stuffed with pieces of cloth or lint, nor should any irritating application whatever be made to it.

### TREATMENT OF SLIGHT WOUNDS.

If no large vessel, but many small ones, are divided, there is usually no danger from excessive hemorrhage. In such instances, press the lips of the wound together for a few minutes; then wash it out with cold water. The bleeding is stayed by the divided vessels retracting into the flesh, and by the contraction of the mouths of the severed arteries.

Fig. 212.

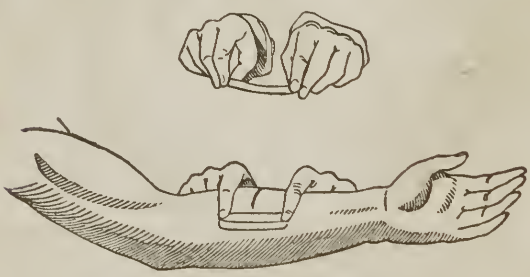

Fig. 212, Represents the manner in which strips of plaster are held and applied to wounds.

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Mention a form for a continued compress. How long should this compression be continued? Should irritating applications be made to wounds?

After the bleeding has ceased, cleanse the wound of coagulated blood and other foreign substances; then bring the divided parts together, and retain them by narrow strips of adhesive or resinous plaster. These should be put on smoothly. Cover the strips of plaster with a thin fold of cloth, and put a bandage loosely around the part.

In most instances, in domestic practice, the strips of plaster used to dress wounds, are much too wide. In all instances, let the cloth be smoothly covered with the plaster. Cut it into narrow strips, not more than one fourth of an inch wide; apply a sufficient number of them to cover the wound.

Fig. 213.

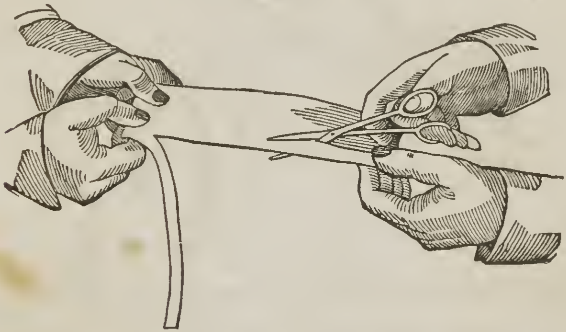

Fig. 213. Represents the manner of cutting these strips.

In a simple wound dressed in this way, the dressings need not be removed for *five* or *six* days; when they are removed, the parts may be cleansed by washing with weak soap-suds or warm water, and if needed, fresh strips of adhesive plaster may be applied. In removing the dressing from a wound, remember to raise each end of the strip of plaster and draw it toward the wound. This is important, as the liability of the wound re-opening is thus diminished. It will be well, perhaps, to say a word or two against the common practice of applying irritating substances, such as *balsams* and *healing salve*, in fresh cuts. They only aggravate the wound, cause more pain, and

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What should be the treatment of slight wounds? How broad should the adhesive strips be cut? What caution is given in removing dressings from a wound? What is the effect of applying balsams and healing salves?

prevent its healing by what surgeons call the first intention,—that is, by the immediate union of its edges. One thing is always to be remembered, *nature* does the cure in all cases of wounds, and the only object of the dressing is to keep the parts together, and protect the wound from air and impurities.

If a wound be ragged, dirty, or what is called a *lacerated wound*, apply cold water, and let it be seen by a surgeon as soon as possible.

Fig. 214.

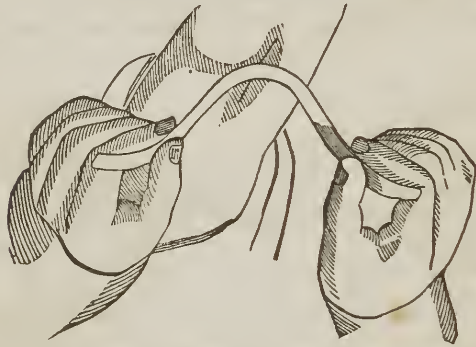

Fig. 214. Represents the proper manner of removing strips of adhesive plaster from wounds.

The proper position of the limbs favors the union of wounds.

If a wound be upon the anterior part of the thigh, by bending the thigh upon the body and extending the knee, the wound will be closed. If the wound be upon the back part of the thigh, by extending the thigh upon the body and flexing the knee, it will favor its closing. If the wound be upon the anterior part of the leg, between the knee and ankle, extending the knee and flexing the ankle, will aid its closing. If the wound be upon the back part of the leg, between the ankle and knee, by extending the foot and bending the knee, the gaping of the wound will be diminished. In wounds upon the anterior part of the trunk of the body, by keeping the body flexed, the wound will be lessened. In wounds upon the

What is the treatment of lacerated wounds? Describe how different parts of the system can be placed to favor the union of wounds.

back part of the trunk, by keeping the body straight, the union of such wounds will be aided.

Fig. 215.

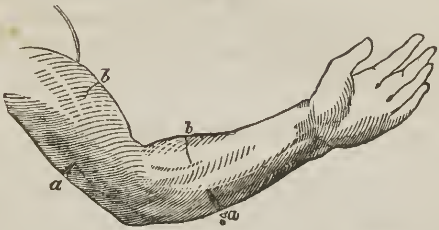


Fig. 215. *a*, *a*, Represent wounds on the back part of the arm and forearm. *b*, *b*, Wounds on the anterior part of the arm and forearm. The arm is represented as flexed at the elbow and wrist. By this bending of the wrist and elbow, the wounds at *a*, *a*, are opened, while the wounds at *b*, *b*, are closed. If the arm were extended at the elbow and the hand at the wrist, the wounds *a*, *a*, would be closed, and those at *b*, *b*, would be opened.

## EXTRANEOUS BODIES IN THE EAR.

" Peas, beans, tamarind stones, and numerous other extraneous bodies, may be introduced into the ear by children, and if not extracted, cause much pain, swelling, and perhaps a formation of matter. If within sight, they may be generally extracted with a small pair of forceps or tweezers, or a double hair pin may be bent into a blunt hook at its bent end, so as to form a kind of scoop, and passed behind the substance, which in this way may be extracted. A stream of warm water, thrown in by means of a small syringe, may sometimes prove successful, and in its return wash out, if it be small, the substance which has been introduced.

"Should the extraneous body be a bean or pea, or any of the grains, water ought not to be used, as the moisture would cause it to swell, and it would afterward be found much more difficult to extract it.

"When much difficulty is met with, the substance ought not to be picked at too long, nor ought an unprofessional person to endeavor for a long time to extract it, for by so doing, not only is inflammation more likely to be excited, but more diffi-

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How can foreign bodies be removed from the external ear? Should water be thrown into the ear, if the foreign body is any of the grains? Should attempts to remove such bodies be long continued? Why?

culty will be experienced by the surgeon, in his attempts to extract it; under such circumstances, send for a surgeon without delay.

"Worms and insects sometimes find their way into the ear, producing severe pain and causing much terror to the patient. These can usually be driven out by the introduction of a little warm olive or almond oil."

### EXTRANEOUS BODIES IN THE NOSTRILS.

Foreign bodies are sometimes introduced into the nostrils by children, causing irritation, and sometimes inflammation, if allowed to remain. They should therefore be removed as soon as possible. This can be done by using the forceps, tweezers, or a blunt hook, as directed in the section on removing foreign bodies from the ear; or they may be pushed back into the throat. Care should be taken not to injure the bones nor the lining membrane of the nostrils. If the substance be not easily extracted, a surgeon should be obtained at once.

### EXTRANEOUS BODIES IN THE THROAT.

"These accidents are very frequent, always alarming, and sometimes of fatal occurrence. It is an accident which requires immediate relief, or life may be lost. It is therefore very desirable that every one should know what to do in such a case.

"It is not necessary to ascertain which passage the foreign body is in, when this accident takes place, for the immediate treatment ought to be the same. A bystander should place one hand flat on the front of the chest of the sufferer, and with the other give two or three smart blows upon the back, allowing a few seconds to intervene between them. This will generally be successful, and cause the substance to be violently ejected.

"If the sufferer be a child, it should be taken between the knees of the operator, who should be seated on a chair, and the same proceedings practised.

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How can worms and insects be dislodged from the ear? How can foreign bodies be removed from the nose. What method should be pursued to remove a foreign body from the throat? How should a person proceed if the sufferer is a child?

"If not successful after a few attempts, a surgeon ought to be obtained as soon as possible; who, if in time, may save the life of the patient."

## EXTRANEOUS BODIES IN THE EYE.

Small particles or dust may become lodged in the eye, and produce much inconvenience and irritation, which are often increased by harsh attempts to remove them. The attempt to remove them should be made in the following way:

The person should be placed before a strong light, the lids held open with one hand, or by an assistant, and the particles brushed away with the corner of a fine cambric or silk handkerchief. Sometimes the substance is concealed under the upper eyelid, and it may then be exposed by turning back the lid in the following manner:

Take a knitting needle, or small slender piece of stick which is perfectly smooth, and place it over the upper lid, in contact with, and just under the edge of the orbit; then, holding it firmly, seize the lashes with the fingers of the disengaged hand, and gently turn the lid back over the stick or needle.

You can then examine the inner side of the lid, and remove any substance that may have been there concealed. Too many trials ought not to be made, if unsuccessful, as much inflammation may be induced by so doing; but a surgeon, in such cases, ought to be consulted as soon as possible.

Machinists, cutlers, and other artisans, are liable to have small, sharp pieces of steel or iron fly into the eye. These can usually be removed (if the person attempting it have a steady hand) with the point of a fine pen-knife, or by a needle.

Eye-stones ought never to be placed in the eye, as they often cause more pain and irritation than the evil which they are intended to remedy.

## MANAGEMENT OF FRACTURES AND DISLOCATIONS.

In cases of supposed fracture or dislocation of the lower extremity, the person should be carefully placed upon a bed

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How can foreign bodies be wiped from the eye? What should be the position of the patient? How should the lids be held? How can the upper lid be turned up? How can small pieces of steel be removed from the eye? Should eye-stones be put into the eye? In fracture or dislocation of the lower extremity, how should the limb be placed?

or sofa, if he be at home, the parts placed in the most comfortable position, and a surgeon sent for immediately.

If the injury be of the upper extremity, the part should be placed and supported in the most comfortable attitude.

The bystanders ought not to handle the affected part any more than is absolutely necessary to place it in the most comfortable position; and above all, they ought to avoid making any attempt to set bones, as much injury may be caused by so doing.

Cloths wet with water, either cold or warm, as may be most agreeable to the patient, may be applied to the part. Such an accident may happen away from home, and even at a distance from any house. In such a case, a litter should be constructed as speedily as possible, the patient laid upon it, and conveyed to his home. If near a house, a litter can be easily constructed, by taking two boards sufficiently wide and long, and nailing them to two narrow cross-pieces, which will answer for handles. The boards may be covered with a folded blanket, or counterpane, or a narrow mattress may be placed upon them. A settee, upon which two or three pillows are placed, will answer the purpose very well.

## CONCUSSION OF THE BRAIN.

In injuries of the brain, the symptoms are usually alarming, and all should possess some information for such contingencies. In general, such accidents are attended by insensibility; the skin and extremities are pale and cold, the pulse is very weak and feeble, and the circulation is much reduced in power; the respiration also is less deep, full, and complete, and is reduced in frequency.

*Treatment.* — In the first instance, the individual should be placed in pure air, and friction and dry warmth should be applied to the pallid and cold skin. This should be assiduously persevered in, until heat and color are restored to the skin and limbs, and due action of the heart and arteries has been established. Mild stimulants may also be used internally, with much advantage. The sympathizing friends should not

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How in the injury of the upper extremity? Ought injured limbs to be much handled? Should the by standers attempt to set them? With what should they be wet? How can a litter be constructed? Mention some of the effects arising from injuries of the brain The treatment.

be permitted to stand about the patient, as they vitiate the air, as explained in the Sections upon the Lungs. There should be no bleeding until the skin and extremities become warm.

## REMOVAL OF DISEASE.

SICKNESS is generally the penalty for doing wrong, physically; yet God has kindly provided for the relief of it. This provision consists in the power of the system to remove diseased actions. The energies of the constitution may be aided in their work of restoration, in two ways. 1st, By removing all the causes that tend to produce disease, or to continue it. 2d, By aiding and assisting the natural action of the system in its efforts to remove disease.

The causes of disease have been pointed out under the head of PRACTICAL SUGGESTIONS, to which the scholar is referred. The powers of the system may be assisted in their efforts to establish health, in the following manner:

1st. FOOD. Ordinarily, in all acute diseases, the patient does not desire food; and, if it is taken and digested, the disease will be much increased by the stimulation of the chyle, when converted into blood. If it is not digested, it will add to the prostration of the system, by the irritation of the mucous membrane of the digestive organs; so that in *all instances* of acute disease, food should be withheld for some days, while the thirst is allayed by cold water, barley water, apple water, crust coffee, &c.

When a patient is recovering from illness, the food should be given with regularity, and in quantities not so great as to oppress the system, and not too frequently. (*See Chapter on Digestive Organs.*) In all instances where a physician has been called, the food should be under his *special* direction, particularly after medicine is withdrawn, and the patient is recovering; as there are many examples of recurrence of disease, produced by injudicious use of food.

2d. BATHING. By the action of the oil and perspiratory glands of the skin, a great amount of injurious waste matter

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In how many ways may the constitution be aided in removing disease? What are they? What is said in regard to food? When should the food be taken under the special direction of the physician? Why is it necessary to bathe in the removal of disease?

is removed from the system. In disease, these glands have their action much diminished. Their ducts also will become obstructed, if the residual products are suffered to remain upon the skin. This inaction and obstruction very much increases the oppression of the diseased organs. Consequently, removing this condition of the skin, by attending to *bathing* and friction, is a powerful means of restoring the system to such a condition, as will expedite a return to health. (*See Chapter on the Skin, particularly the section on Bathing.*)

3d. Pure air. This is not only essential in preventing, but it is of the utmost importance in removing disease. This arises from the fact, that when the system is stimulated by pure blood, its power is greater to remove disease, than when the blood is defective in quality, by not having the carbon removed from it by a proper supply of pure air. Hence, the custom of keeping the room of sick persons close, and the air impure, for fear the patient " will take cold," is exceedingly pernicious. There is no question, but that disease, in many instances, becomes severe, dangerous, and even fatal, from the air of the patient's room being kept confined and impure, that would have been mild and of short continuance, if the apartment of the person had been properly ventilated. Stoves, particularly the "air-tight," are among the greatest evils to which the sick in New England are subject. (*See Chapter on the Lungs. — Practical Suggestions.*)

4th. Rest, is absolutely necessary to a person suffering from disease. By this, I mean, not only a cessation of *muscular labor*, but of *mental action*. Consequently, when a person is indisposed, if only slightly, the brain should not be kept toiling and excited by the noise and conversation of neighbors and friends. Conversation upon the details of business operations, and *exciting* and *important* topics, should be excluded from the room of the sick. To these rooms, there should be no privileged topic or set of visitors. These remarks apply as forcibly to the apartment of the *sick child*, as that of an adult. The more dangerous, and apparently the nearer death, is the sick person, the more rigorous should be the observance of the rule to exclude all unnecessary visitors. The

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Show the necessity of having pure air in the sick room? Should stoves be used in the sick room? Should there be a cessation of mental action, as well as muscular labor, during sickness? What is said in regard to receiving visitors in the sick room?

custom of visiting and conversing with sick friends in the intervals of customary toil, particularly on the SABBATH, is a great evil. The habit is a gross nuisance, and will not be practised by any person who cares more for the welfare of a sick friend than the gratification of a *sympathetic curiosity.*

5th. NURSES, and sometimes "watchers," are necessary to carry out the suggestions under the preceding heads. A nurse should be kind, attentive, firm, and cheerful, in presence of the patient. She needs both a theoretical and practical knowledge of the principles and practices upon which health and comfort depend. Without such knowledge, she will not act with uniform consistency in discharging her duties to the sick. Woman is the natural nurse of the child, sister, brother, husband, father, and mother; hence, every girl should become familiar with the principles of *practical physiology.* It is an accomplishment indispensable to a complete female education, and more important than music and dancing.

A temporary "watcher" should have qualifications of a character similar to those described as indispensable to the nurse. As persons taken from the field and shop usually are deficient in this respect, it would be much more humane and economical to employ and *pay* watchers, who are qualified by knowledge and *training* to perform this duty in a faithful manner, while the kindness and sympathy of friends may be *practically* manifested, by assisting to defray the expenses of these qualified and needful assistants.

6th. MEDICINE is sometimes necessary to *assist* the natural powers of the system to remove disease; but it is only an *assistant,* and always an *evil;* yet, it may induce an action that is less dangerous than that of the disease for the relief of which it is given. While emetics are occasionally useful in removing from the stomach food and other articles that would cause disease if suffered to remain, and cathartics are valuable in some instances to relieve the intestines of irritating residuum, yet the frequent administration of either would cause serious disease. The same remarks may be made relative to the use of opium to relieve pain, and stimulating bitters, to create appetite.

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What qualifications should nurses possess? Who is the natural nurse? What is said of the qualifications of temporary watchers? Does medicine truly cure disease? What is its office? Should medicines be taken frequently?

Although medicine is useful in some instances, yet, in a great proportion of the cases of disease, including fevers and inflammations of all kinds, attention to the suggestions under the preceding heads will tend to relieve the system from disease more certainly and speedily, and with less danger, than when medicines are administered. Thomas Jefferson, in writing to Dr. Wistar of Philadelphia, said, "I would have the physician learn the limit of his art." I would say, have the matrons, and those who are continually advising "herb teas, pills, powders, bitters," and other "cure alls" for any complaint, labelled with some popular name, learn the limits of their duty, namely, attention to the laws of health. Future generations will look upon the administration of medicine, as now pursued, with as much astonishment and regret, as we view the habitual use of intoxicating drinks. The rule of every family and each individual should be, to touch not, taste not of medicine of *any kind*, except when directed by a well educated and honest physician, (sudden disease from accidents excepted.)

## POISONS AND THEIR ANTIDOTES.

Poisoning, either from accident or design, is of such frequency and danger, that it is of the greatest importance that every person should know the proper mode of procedure in such cases, in order to render immediate assistance, when within their power.

Poisons are divided into two classes. *Mineral* (which will include the acids) and *vegetable.*

The first thing to be done, when it is ascertained that a poison has been swallowed, is, to evacuate the stomach; unless vomiting takes place spontaneously. Emetics of the sulphate of zinc, (white vitriol,) or ipecacuanha, (ipecac,) or the wine of antimony, should be given.

When vomiting has commenced, it should be aided by large and frequent draughts of the following drinks: Flaxseed tea, gum water, slippery elm tea, barley water, sugar and water, or anything of a mucilaginous or diluent character.

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What did the late Thomas Jefferson remark to Dr. Wistar? What should matrons learn? What rule is given to every individual in regard to taking medicine? What exception? Into how many classes may poisons be divided?

## MINERAL POISONS.

Ammonia. — The *water of ammonia*, if taken in an over-dose and in an undiluted state, acts as a violent corrosive poison.

The best and most effectual antidote is *vinegar*. It should be administered in water without delay. It neutralizes the ammonia, and renders it inactive. Emetics should not be used in these cases.

Antimony. — The *wine of antimony and tartar of emetic*, if taken in over-doses, cause distressing vomiting. In addition to the diluent mucilaginous drinks, give a tea-spoonful of the syrup of poppies, paregoric, or twenty drops of laudanum, every twenty minutes, until five or six doses have been taken, or the vomiting ceases.

The antidotes are *nut galls* and *oak bark*, which may be administered in infusion.

Arsenic. — When this has been taken, administer an emetic of ipecac, speedily, in mucilaginous teas, and use the stomach-pump as soon as possible.

The antidote is the *hydrated peroxide of iron*. It should be kept constantly on hand at the apothecaries' shops. It may be given in any quantity, without injurious results.

Copper. — The most common cause of poisoning from this metal, is through the careless use of cooking utensils made of it, on which the *acetate of copper* (*verdigris*) has been allowed to form. When this has been taken, immediately induce vomiting, give mucilaginous drinks, or, what is still better, the *white of eggs* diffused in water.

The antidote is the *carbonate of soda*, which should be administered without delay.

Lead. — The *acetate* (*sugar*) *of lead* is the preparation of this metal which is liable to be taken accidentally in poisonous doses. Induce immediate vomiting, by emetics and diluent drink.

The antidote is diluted *sulphuric acid*. When this acid is not to be obtained, either the sulphate of magnesia (epsom

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What is the antidote when ammonia is too freely taken? Should emetics be given? The antidotes for antimony? What should be the treatment when arsenic is taken? How is poisoning from copper generally produced? The remedy? The antidote? The remedy for the acetate of lead?

salts) or the sulphate of soda (glauber's salts) will answer every purpose. They should be given in weak solution.

MERCURY.—The preparation of this mineral by which poisoning is commonly produced, is *corrosive sublimate.* The mode of treatment to be pursued when this poison has been swallowed, is as follows. The *whites of a dozen eggs* should be beaten in two quarts of cold water, and a tumbler-full given every two minutes, to induce vomiting. When the whites of eggs are not to be obtained, soap and water should be mixed with wheat flour, and given in copious draughts, and the stomach-pump introduced as soon as possible. Emetics or irritating substances ought not to be given.

NITRE — *Saltpetre.* This, in over-doses, produces violent poisonous symptoms. Vomiting should be immediately induced, by large doses of mucilaginous diluent drinks; but emetics which irritate the stomach ought not to be given.

ZINC. — Poisoning is sometimes caused by the *sulphate of zinc* (white vitriol.) When this takes place, vomiting should be induced, and aided by large draughts of mucilaginous and diluent drinks. Use the stomach-pump as soon as possible.

The antidote is the *carbonate* or *super-carbonate of soda.*

NITRIC, (aqua fortis,) MURIATIC, (marine acid,) or SULPHURIC, (oil of vitriol,) ACIDS may be taken by accident, and produce poisonous effects.

The antidote is *calcined magnesia*, which should be freely administered, to neutralize the acid and induce vomiting. When magnesia cannot be obtained, the *carbonate of soda* or *potash* may be given. *Chalk*, powdered and given in solution, or strong *soap suds*, will answer a good purpose when the others are not at hand. It is of very great importance that something be given speedily, to neutralize the acid. One of the substances above named should be taken freely, in diluent and mucilaginous drinks, as gum-water, milk, flax-seed or slippery-elm tea. Emetics ought to be avoided.

OXALIC ACID.—This acid resembles the sulphate of magnesia, (epsom salts,) which renders it liable to be taken, by

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What should be given when corrosive sublimate has been swallowed? What should not be given? The remedy when saltpetre is taken? When zinc? The antidote? What will neutralize nitric, muriatic, or sulphuric acids? What should be avoided? What does oxalic acid resemble?

mistake, in poisonous doses. Many accidents have occurred from this circumstance. They can easily be distinguished by tasting a small quantity. The *epsom salts*, when applied to the tongue, have a very bitter taste, while the *oxalic acid* is intensely sour.

The antidote is *magnesia*, between which and the acid a chemical action takes place, producing the oxalate of magnesia, which is inert. When magnesia is not at hand, *chalk*, *lime*, *carbonate of soda*, or *carbonate of potash*, (salæratus,) will answer as a substitute.

Give the antidote in some of the mucilaginous drinks before named. No time ought to be lost, but the stomach-pump should be introduced as soon as a surgeon can be obtained.

Ley.—The ley obtained by the leaching of ashes, may be taken by a child accidentally. The antidote is vinegar, or oil of any kind. The vinegar neutralizes the alkali, by uniting with it, forming the acetate of potash. The oil unites with the alkali, and forms soap, which is less caustic than the ley. Give, at the same time, large draughts of mucilaginous drinks, as flax-seed tea, &c.

## VEGETABLE POISONS.

The vegetable poisons are quite as numerous, and many of them equally as violent, as any in the mineral kingdom. We shall describe the most common, and which, therefore, are most liable to be taken.

Opium.—This is the article most frequently resorted to by those wishing to commit suicide, and as it is used as a common medicine, is easily obtained. From this cause, also, mistakes are very liable to be made, and accidents to occur with it. Two of its preparations, *laudanum* and *paregoric*, are frequently mistaken for each other; the former being given when the latter is intended.

*Morphia*, in solution, or *morphine*, as it is more commonly called by the public, is a preparation of the drug under con-

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How can it be detected? The antidotes? How should they be taken? The antidote when ley is taken into the stomach? What is said of vegetable poisons? What vegetable poison is quite frequently taken? Some of the reasons why taken more than others? What is morphia?

sideration, with which many cases of poisoning are produced. It is the active narcotic principle of the opium, and one grain is equal to six of this drug in its usual form.

When an over-dose of opium, or any of its preparations, has been swallowed, the stomach should be evacuated as speedily as possible. To effect this, as much tartar emetic as can be held on a ten cent piece, or as much *ipecacuanha* as can be held on a twenty-five cent piece, should be dissolved in a tumbler of warm water, and one half given at once, and the remainder in twenty minutes, if the first has not in the mean time operated. In the interval, copious draughts of warm water, or warm sugar and water, should be drank. The use of the stomach-pump, in these cases, is of the greatest importance, and should be resorted to without delay. After most of the poison has been evacuated from the stomach, a strong infusion of *coffee* ought to be given; or some one of the vegetable acids, such as *vinegar* or *lemon juice*, should be administered.

The patient should be kept in motion, and salutary effects will often be produced by dashing a bucket of cold water on the head. *Artificial respiration*, as recommended in the section on asphyxia from drowning, ought to be established and kept up for some time. If the extremities are cold, apply warmth and friction to them. After the poison has been evacuated from the stomach, stimulants, as warm wine and water, or warm brandy and water, ought to be given, to keep up and sustain vital action.

STRAMMONIUM — *Thorn-apple.* This is one of the most active narcotic poisons, and when taken in over-doses, has in numerous instances caused death.

The treatment — similar to that recommended in poisoning from opium.

HYOSCIAMUS — *Henbane.* This article, which is used as a medicine, if taken in improper doses, acts as a violent irritating and narcotic poison.

*Treatment*, — similar to that of poisoning from over-doses of opium.

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How much stronger than gum opium? What is the remedy? May the stomach pump be advantageously used for this poison? What further directions are given for such cases? What is one of the most active narcotic poisons? The remedy when an over-dose of strammonium is taken? What is the effect of henbane when taken in improper doses?

CONIUM — *Hemlock* Hemlock, improperly called by many, *cicuta*, when taken in an over dose, acts as a narcotic poison. It was by this narcotic that the Athenians used to destroy the lives of individuals condemned to death by their laws. Socrates is said to have been put to death by this poison.

When swallowed in over doses, the treatment is similar to that of opium, strammonium and henbane, when over-doses are taken.

BELLADONNA — *Deadly Night-shade.* CAMPHOR. ACONITE — *Monkshood, Wolfsbane.* BRYONY — *Bryonia.* DIGITALIS — *Foxglove.* DULCAMARA — *Bitter-sweet.* GAMBOGE. LOBELIA — *Indian tobacco.* SANGUINARIA — *Blood-root.* OIL OF SAVIN. SPIGELIA—*Pink-root.* TOBACCO. STRYCHNINE — *Nux-vomica.* — All of these, when taken in over doses, are poisons of greater or less activity. The treatment of poisoning by the use of any of these articles, is similar to that pursued in over-doses of opium. *(See Opium, page 327.)*

In *all* cases of poisoning, call a physician as soon as possible.

## SIGNS OF REAL DEATH, AND MEANS OF DISTINGUISHING IT FROM SUSPENDED ANIMATION.

It is no uncommon occurrence, that persons considered dead, have been restored to life at the moment when a post mortem examination was to have been made, or even when they were in the coffin or tomb. This mistake arises from the difficulty of distinguishing *real* from *apparent* death.

1st. One of the most certain signs of death, is the stiffness of the corpse. Sometimes, however, this sign manifests itself during life. This renders it necessary to observe the differences between the stiffness of death, and that which affects a person laboring under suspended animation, or disease.

When a limb is stiff from *tetanus* or *convulsions*, its position is changed with difficulty, and when this has been done, it immediately returns to its former state. In the stiffness of death, the position of a limb is easily changed, and it remains where last placed.

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Name other vegetable poisons. The treatment when taken in too large quantities.

In *fainting*, or asphyxia, from strangulation or impure air, the rigidity takes place immediately, and the breast and abdomen retain their heat. The rigidity of a corpse does not take place until some time after death, and when we can no longer perceive any heat in the body.

The inflexibility noticed in suspended animation, is easily distinguished from the stiffness of death. Suppose a person to be in a state of suspended animation ten or fifteen minutes, when the limbs are inflexible. It is impossible that this stiffness can be the result of death, since the bodies of those who die of asphyxia do not become stiff for several hours.*

A person in a frozen state will be rigid, when not dead, and capable of being restored. In this state, the *skin*, *breast*, *abdomen*, and all the organs, are as stiff as the muscles, which is not the case in the rigidity of a corpse, in which the muscles alone offer much resistance. When the position of a frozen member is changed, a slight noise is produced by the breaking of the icicles contained in the part moved. This noise is not heard in the coldness of death.

2d. If an individual be supposed to have been dead a long time, and become *cold* and *soft*, the interment ought not to be hastened. Before deciding that death has taken place, a muscle of the arm or thigh should be laid bare, and electrified by means of the galvanic battery. If no sign of contraction appear, life may be considered extinct; if contraction take place, the individual is not dead, and the means directed for restoring the action of the heart and lungs, in asphyxia from drowning, should be adopted.

3d. The sign of death most certain, is *well-marked putrefaction; but it does not belong to the unprofessional, to decide whether or not putrefaction has commenced; the physician alone can establish the fact.* Persons have often been seen with purple blotches and some other signs of putrefaction, and emitting an offensive odor, who were restored after a lapse of some hours, by the aid of appropriate remedies. Under some circumstances, those appearances take place from the mortification of a limb. The appearances of the face and eyes are not to be relied on as criteria of death. The aspect that they generally present is sometimes wanting, and at other times they are seen forty-eight hours before death.

* The more sudden the death, the slower the rigidity takes place.

4th. The impossibility of feeling the beating of the heart and the pulsation of the arteries, is no certain indication of death, as it is fully proved that a person may live many hours without these pulsations being perceived.

5th. An individual has been considered dead *when he ceases to breathe;* but experience proves that life may not be extinct, although no manifestation of the continuance of respiration can be perceived, by applying the flame of a candle to the nostrils, or a mirror before the mouth.

6th. It has been thought that a person is dead when he is cold, and that he is alive if he preserves his warmth. This is of the least value of all the signs; for drowned persons, who can be restored to life, are ordinarily very cold; whilst those suffocated, etc., preserve their heat even a long time after death.

7th. The sensibility of a patient may be destroyed in some diseases, so that incisions and blisters will not be felt by one who may ultimately recover, so that the absence of sensibility is no certain indication of death.

The inference from the preceding explanations shows—First, That no one of the signs enumerated, taken by itself, (except well-marked putrefaction,) is sufficient for pronouncing a person's life extinct. Secondly, That death ought to be regarded as real, in an individual who combines all these signs.

# GLOSSARY.

*Ab-duc'tor.* A muscle which moves certain parts, by separating them from the axis of the body. Fig. 72.
*Ad-duc'tor.* A muscle which draws one part of the body towards another. Fig. 69.
*Al-bu-gin'ea.* A term applied to white textures.
*Al'i-ment.* Food, nourishment.
*A-nas'to-mose.* The communication of vessels with each other.
*A-nat'o-my.* The description of the structure of animals. The word anatomy, properly signifies dissection.
*An-a-tom'i-cal.* Relating to the parts of the body, when dissected or seperated.
*An-co-ne'us.* A term once applied to every muscle attached to the elbow. Now, only to one.
*An'gu-li.* A term applied to certain muscles. Fig. 58.
*An-i-mal'cu-læ.* Animals that are only perceptible by means of a microscope.
*An'nu-lus.* Having the form of a ring.
*An-se-ri'na.* Resembling the skin of a goose.
*An-ten'næ.* The horns or feelers of insects projecting from the head.
*An-te'ri-or.* Before or in front in place.
*An'ti-cus.* Anterior.
*An'trum.* A cavity.
*A-ort'a.* The great artery that arises from the left ventricle of the heart. Fig. 145.
*Ap-o-neu-ro'sis.* The membranous expansions of muscles and tendons.
*Ap-pa-ra'tus.* An assemblage of organs.
*A-rach'noid.* Resembling a spider's web. A membrane of the brain.
*Ar'bor.* A tree; *arbor vitæ*, the tree of life. Fig. 168.
*Ar-te'ri-a.* An artery; a tube through which blood flows from the heart.
*Ar-tic'u-late.* The union of bones with each other.
*A-ryt-e'noid.* The name of a cartilage of the larynx. Fig. 124.
*As-cen'dens.* Ascending; rising.
*As-phyx'ia.* Suspended animation. Now used for suspended respiration.
*As-trag'a-lus.* The name of a bone in the foot. Fig. 34.
*At'mos-phere.* The air which surrounds the earth.
*At-tol'lens.* The name of a muscle that elevates a part. Fig. 129.
*At'tra-hens.* The name of a muscle of the ear. Fig. 129.
*Aud-i'tion.* Hearing.
*Au'ri-cle.* A cavity of the heart. Fig. 138.
*Au-ric'u-lar.* Pertaining to the auricle.
*Au'ris.* An ear.
*Ax'il-la.* The arm pit.
*Ax'il-la-ry.* Belonging or relating to the arm pit.
*A-zote'.* Nitrogen. One of the constituent elements of the atmosphere.
*Az'a-gos.* The name of a vein.

*Bi'ceps.* A name applied to muscles with two heads at one extremity Fig. 66.

*Bi-cus'pids.* Teeth, tbat have two points upon their crowns. Fig. 18.
*Bile.* A yellow, viscid fluid secreted by the liver.
*Brach'i-al.* Belonging to the arm.
*Bre'vis.* Sbort.
*Bre'vi-or.* Shorter.
*Bron'chus, chi.* A division of the trachea that passes to tbe lung. Fig. 111.
*Bron'chi-al.* Relating to the bronchi.
*Bron-chi'tis.* An inflammation of the bronchi.
*Buc'cal.* Relating to the cheeks.
*Buc-ci-na'tor.* The name of a broad muscle in the cheek. Fig. 59.
*Bur'sæ Mu-co'sæ.* Small sacs, containing a viscid fluid, situated about the joints, under tendons. Fig. 38.

*Cal'cis.* The hcel bone. Fig. 34.
*Cap'il-la-ry.* Hair-like, small.
*Cap'sule.* A membranous bag, enclosing a part.
*Cap'su-lar.* Pertaining to capsule.
*Ca'put.* The head; *caput coli*, tbe head of the colon. Fig. 104.
*Car'bon.* Pure charcoal.
*Car-bon'ic.* Pertaining to carbon.
*Car'di-ac.* Relating to tbe beart; or npper orifice of the stomach. Fig. 104.
*Car'pal.* Relating to the wrist.
*Car'pus.* Tbe wrist. Fig. 30.
*Car'ne-æ.* Fleshy.
*Ca-rot'id.* The great arteries of the neck, that convcy blood to the head. Fig. 145.
*Car'ti-lage.* Gristle. A smooth, elastic substance, softer than bone.
*Cæ'cum.* Blind; the name givcn to the commencement of the colon. Fig. 104.
*Cœ-li'ac.* The name of an artery.
*Cau-ca'si-an.* One of the races or classes of men.
*Ca'va.* Hollow; *vena cava*, a name given to the two great veins of the body. Fig. 161.
*Cel'lu-lar.* Composed of cells.
*Ce-phal'ic.* Pertaining to the head.
*Cer-e-bel'lum.* The little brain; the inferior and posterior portion of the brain. Fig. 168.
*Cer'e-bral.* Relation to the brain.
*Cer'e-brum.* The brain; the term is sometimes applied to the whole contents of the cranium; at others to the upper portion. Fig. 168.
*Ce-re'bro-Spi'nal.* Relating to the brain and spine.
*Ce-ru'men.* A secretion witbin the ear; wax.
*Ce-ru'min-ous.* Relating to cerumen.
*Cer'vix.* The neck.
*Cer'vi-cal, is.* Relating to tbe neck.
*Chest.* Tbe trunk of the body from tbe neck to the abdomen.
*Cho-led'o-chus Duct.* Tbe duct which conveys tbe bile into the duodenum.
*Chor'da, æ.* A cord. An assemblage of fibres.
*Cho'ri-on*, or *Corion.* The true skin.
*Cho'roid.* A term applied to several parts of the body that resemble the skin. Fig. 190.
*Chyle.* A nutritive fluid, of whitish appearance.
*Chyme.* A kind of grayish pulp, formed from the food after it has been for some time in the stomach.
*Cil-i'a.* The cye lashes.
*Cil'ia-ry.* Belonging to the eye lids.
*Cin-e-ri'tious.* Resembling asbes.
*Clav'i-cle.* The collar bone.
*Cle-i'do.* Relating to the clavicle. Fig. 58.
*Coc'cyx.* An assemblage of bones joined to the sacrum. Fig. 24.
*Coch'le-a.* A cavity of the ear, resembling a snail-shell. Fig. 197.
*Co'lon.* A portion of the large intestines. Fig. 104.
*Co-lum'na.* A column or pillar.
*Com-plex'us.* The name of a muscle of the neck. Fig. 65.
*Com-pres'sor.* A muscle that comprcsses, or forccs the part to wbich it is attachcd into closer union.
*Com'mu-nis.* Common.
*Con'cave.* Hollow; as the inner surface of a spherical body.
*Cond'yle.* A protuberance on the cnd of a bone.

*Con-junc-ti'va.* The membrane that covers the anterior part of the globe of the eye and the inner surface of the eye-lids.
*Con'vex.* Bilging; as the exterior surface of a spherical body.
*Cor'a-co.* Names compounded with this word belong to muscles which are attached to the *coracoid* process of the scapula.
*Corn'e-a.* The transparent membrane in the fore part of the eye. Fig. 190.
*Cor'nu.* A horny excrescence.
*Cor'o-nal.* Belonging to the crown, or top of the head.
*Cor'pus Cal-lo'sum.* A hard body; the name of a part of the brain. Fig. 168.
*Cor-ru-ga'tor.* The muscle which contracts the skin of the forehead into wrinkles.
*Cos'ta.* Rib.
*Crib'ri-form.* Resembling a sieve.
*Cri'coid.* A name given to a cartilage of the larynx. Fig. 123.
*Crus, Cru'ra.* Applied to some parts, from their analogy to a leg.
*Cu nei-form.* The name of bones in the hand and foot. Fig. 30.
*Cu-ta'ne-ous.* Belonging to the skin.
*Cu'ti-cle.* The external layer of the skin. Fig. 8.
*Cu'tis Ve'ra.* The internal layer of the skin.

*Del'toid.* Resembling the Greek Δ. The name of a muscle. Fig. 64.
*Dens.* A tooth.
*Den'tal.* Pertaining to the teeth.
*De-press'or.* A muscle that depresses or draws down the part to which it is attached. Fig. 58.
*De-scen'dens.* Descending; falling.
*Di'a-phragm.* The midriff; a muscle separating the chest from the abdomen. Fig. 63.
*Di-a-phrag-mat'ic.* Pertaining to the diaphragm.
*Di-ar-rhe'a.* A disease characterized by frequent liquid, alvine evacuations.
*Di-gas'tri-cus.* An epithet given to a muscle of the lower jaw. Fig. 130.
*Di-ges'tion.* The process of dissolving food in the stomach, and preparing it for circulation and nourishment.
*Dig'it.* The measure of a finger's breadth, or $\frac{3}{4}$ of an inch.
*Dig'i-tal.* Pertaining to the fingers.
*Dor'sum.* The back.
*Dor'sal.* Pertaining to the back.
*Du-od'e-num.* The first of the small intestines, being about 12 fingers' breadth. Fig. 104.
*Du'ra.* Hard.
*Dys'en-ter-y.* A disease characterized by bloody and mucus alvine evacuations, accompanied by tenesmus.
*Dys-pep'sia.* Bad digestion.

*E-mulg'ent.* The name applied to the renal arteries. Fig. 149.
*En-am'el.* The smooth, hard substance, which covers the crown of the teeth.
*En'si-form.* The name of a cartilage at the extremity of the sternum.
*Ep-i-derm'is.* The scarf-skin of the body. Fig. 8.
*Ep-i-gas'tric.* Pertaining to the upper part of the abdomen.
*Ep-i-glot'tis.* One of the cartilages of the larynx. Fig. 127.
*E-rec'tor, us.* Made erect, or upright.
*Eth'moid.* Sieve-like; a bone of the nose. Fig. 186.
*Eus-ta'chi-an Tube.* This tube is so called from its discoverer, Eustachius. Fig. 196.
*Ex'cre-ment.* That which is discharged from the animal body, after digestion.
*Ex'cre-to-ry.* A little duct or vessel, destined to receive secreted fluids, and to excrete or discharge them; also, a secretory vessel.
*Ex-ha'lant.* To throw out.
*Ex-tens'or.* A muscle which serves to extend or straighten any part of the body. Fig. 70.

*Fa'cial.* Pertaining to the face.
*Falx.* Scythe-shaped; a process of the dura mater. Fig. 165.
*Fas'cia, æ.* A tendinous expansion, or aponeurosis.

*Fas-cic'u-lus, li.* A small bundle of fibres.
*Faux, ces.* The throat, or swallow.
*Fe'mur.* The thigh-bone. Fig. 32.
*Fem'o-ral.* Belonging to the thigh.
*Fe-nes'tra, um.* A window; an opening.
*Fi'bre.* An organic filament or thread, of a solid consistence, which enters into the composition of every animal and vegetable texture.
*Fib'rin.* An organic substance.
*Fi'bro-Car'ti-lage.* An organic tissue, partaking of the nature of fibrous tissue and of that of cartilage.
*Fib'u-la.* The outer and lesser bone of the leg. Fig. 33.
*Fib'u-lar.* Pertaining to the fibula.
*Fil'a-ment.* A fine thread, of which nerves, skin, &c. are composed.
*Fis'sure.* A deep, narrow depression.
*Flex'ion.* The act of bending.
*Flex'or.* A muscle whose office is to bend the part to which it belongs. Fig. 69.
*Fol'li-cle.* A gland; a little bag in animal bodies.
*Fore-arm.* The part of the upper extremity between the arm and hand.
*Fos'sa.* A cavity in a bone, with a large aperture.
*Frœ'num.* A bridle. A name given to several membranous folds, which bridle or retain certain organs.
*Fron'tal, lis.* Belonging or relating to the forehead. Fig. 15.
*Func'tion.* The action of an organ or system of organs.
*Fun'gi-form.* Like fungus or mushroom.

*Gang'li-on, a.* A small circumscribed tumor, found in certain parts of the nervous system. Fig. 183.
*Gas'tric.* Belonging to the stomach.
*Gas-troc-ne'mi-us.* A name of a muscle of the leg. Fig. 76.
*Gel'a-tin.* A concrete animal substance, soluble in water.
*Ge-ni'o.* The chin. Names compounded with this word belong to muscles attached to the chin. Fig. 130.
*Gle'noid.* Any shallow, articular cavity, which receives the head of a bone. Fig. 27.
*Glos'sa.* The tongue. Names compounded with this word are applied to muscles attached to the tongue. Fig. 131.
*Glot'tis.* A narrow opening at the upper part of the larynx. Fig. 126.
*Glu-te'us.* The name given to a muscle of the hip. Fig. 80.
*Grac'i-lis.* Slender. A muscle upon the inside of the thigh. Fig. 73.

*Hem'i-sphere.* One half of a sphere; the brain is divided into two hemispheres.
*Hem'or-rhage.* A discharge of blood from any vessel.
*He-pat'ic.* Pertaining to the liver.
*Hern'i-a.* A descent of the intestines from their natural place.
*Ho-mo-ge'ne-ous.* Of the same kind or nature.
*Hu'mer-us.* The bone of the arm. Fig. 28.
*Hu'mor.* Every fluid substance of an organized body; as the chyle, the blood, &c.
*Hy'a-loid.* Resembling glass The name of a membrane of the eye. Fig. 190.
*Hy-gi'ène.* The part of medicine which treats of the preservation of health.
*Hy'o.* The names compounded with this word belong to the muscles which are attached to the bone of the tongue, (*os hyoides.*) Fig. 131.
*Hy'po.* Under.
*Hy-po-gas'tric.* The lower, front part of the abdomen.

*Il'e-um.* A portion of the small intestines. Fig. 104.
*Il'i-ac.* Relating to the flanks.
*Il'i-um.* The haunch bone. Fig. 62.
*In-ci'sor.* A fore tooth, which cuts or divides. Fig. 17.
*In'dex, ices.* To point out; the fore-finger.
*In-fe'ri-or.* The lower of two parts.

*In'fra.* Below, under.
*In-fun-dib'u-lum.* Funnel-shaped.
*In-nom-i-na'ta.* Parts which have no proper name. Fig. 24.
*In-os'cu-late.* To unite by apposition or contact; to unite, as two vessels at their extremities.
*In-sal-i-va'tion.* The mixture of the food with the secretions of the mouth.
*In'ter.* Between.
*In-ter-cos'tal.* Between the ribs.
*In-ter-no'dii.* The name of some muscles of the fore-arm. Fig. 70.
*In-ter-sti'tial.* Pertaining to interstices, or intervals between organs.
*I'ris.* The membrane around the pupil of the eye. Fig. 189.
*Is-chi-at'ic.* Pertaining to the hip.

*Je-ju'num.* A portion of the small intestines. Fig. 104.
*Ju'gu-lar.* Relating to the throat. The great veins of the neck. Fig. 156.

*La'bi-um, La'bi-i.* Lips.
*Lab'y-rinth.* A place full of turnings; a cavity of the ear.
*Lach'ry-mal.* Pertaining to tears.
*Lac'te-al.* A vessel of animal bodies for conveying chyle from the intestines to the common reservatory. Fig. 99.
*Lamb-doi'dal.* The name of a suture formed by the parietal and occipital bones of the skull. Fig. 14.
*Lam'i-na, æ.* A plate, or thin piece of bone.
*Lar'ynx.* The upper part of the wind-pipe. Fig. 125.
*La'ta, um, issimus.* Broad, large.
*Le-va'tor.* A muscle that serves to raise some part. Fig. 58.
*Lig'a-ment.* A strong, compact substance, serving to bind one bone to another.
*Lin'e-a, æ.* A line, or any long string.
*Lin'gua, æ.* A tongue.
*Lobe.* A round, projecting part of an organ.
*Lon'gus, ior.* An epithet applied to several muscles, to distinguish them from others of similar function, when the latter are shorter.
*Lum'bar.* Pertaining to the loins.
*Lum-bri-ca'les.* Four small muscles of the hand. Fig. 72.
*Lymph.* A colorless fluid in animal bodies, and contained in vessels called *lymphatics* or *absorbents.*

*Mag'nus, um.* Great, large.
*Ma'jor.* Greater.
*Ma'la, æ.* The cheek bone.
*Ma'lar.* Pertaining to the cheek bone.
*Mal-le'o-lar.* Pertaining to the malleolus.
*Mal-le'o-lus.* Two projections formed by the bones of the leg at their inferior extremity. Fig. 33.
*Mas-se'ter.* The name of a muscle of the face. Fig. 59.
*Mas'ti-cate.* To chew.
*Mas'toid.* The name of a process of the temporal bone behind the ear.
*Mas-toi'de-us.* The name of a muscle upon the neck that is attached to the mastoid process. Fig. 59.
*Max-il'la.* The jaw bone.
*Max'il-la-ry.* Pertaining to the jaw.
*Max'i-mum.* The greatest.
*Me-a'tus.* Passage, channel.
*Me'di-um, a.* The space or substance through which a body moves or passes.
*Me'di-us, Me'di-an.* The middle; situated in the middle.
*Me-di-as-ti'num.* A membrane that separates the chest into two parts. Fig. 108.
*Me-dul'la Spi-na'lis.* The spinal cord. Fig. 173.
*Me-dul'la Ob-lon-ga'ta.* Commencement of the spinal cord. Fig. 168.
*Mem-bra'na.* A membrane; a thin, white, flexible skin, formed by fibres interwoven like net-work.
*Mem-bra'nous.* Relating to a membrane.
*Me-nin'ges.* The three membranes that envelope the brain. Fig. 165.
*Me-nin-ge'al.* Pertaining to the meninges.
*Mes'en-ter-y.* A term applied to sev-

eral duplicates of the peritoneum, which maintain the several portions of the intestinal canal in their respective situations.

*Mes-en-ter'ic.* Pertaining to the mesentery.

*Met-a-carp'al.* Relating to the metacarpus.

*Met-a-carp'us.* The part of the hand between the wrist and fingers. Fig. 30.

*Met-a-tar'sal.* Relating to the metatarsus.

*Met-a-tar'sus.* The instep. Seven bones of the foot. Fig. 35.

*Mi'asm, Mi-as-ma'ta.* Infectious substances floating in the air.

*Mid'riff.* See Diaphragm.

*Mi'nor.* Less, smaller.

*Mi'tral.* The name of the valves of the left side of the heart. Fig. 140.

*Mo-di-o'lus.* A cone in the cochlea, around which the membranes wind. Fig. 197.

*Mo'lar, es.* The name of some of the large teeth. Fig. 17.

*Mol'lis.* Soft.

*Mo'tor, es.* A mover.

*Mu'cus.* A viscid fluid secreted by the mucous membrane, which it serves to moisten and defend.

*Mul-tif'i-dus.* The name of a muscle of the back. It signifies having many slits. Fig. 65.

*Mus'cle.* A bundle of fibres enclosed in a sheath.

*Mus'cu-lar.* Relating to a muscle.

*My'lo.* Names compounded of this word belong to muscles that are attached near the molar teeth.

*My'lo-Hy-oi'de-us.* The name of a muscle of the neck. Fig. 130.

*Na'sal.* Pertaining to the nose.

*Na'sus.* The nostrils.

*Na-vic-u-la're.* The name of one of the tarsal bones. Fig. 35.

*Nerve.* An organ of sensation and motion in animals.

*Neu-ri-lem'a.* The sheath or covering of a nerve.

*Ni'tro-gen.* That element or component part of air which is called azote.

*Nu-tri'tion.* The act or process of promoting the growth, or repairing the waste of the system.

*Ob-li'qu-us.* A name attached to several muscles of the system. Fig. 61.

*Ob-tu-ra'tor.* A name given to several parts.

*Oc-cip'i-tal.* That which belongs to the occiput.

*Oc'ci-put.* The back part of the head.

*Oc-u-lo'rum.* Of the eyes.

*Oc'u-lus, i.* The eye.

*Œ-soph'a-gus.* The name of the passage through which the food passes into the stomach. Fig. 92.

*O-lec'ra-non.* The head or projection of the elbow. Fig. 29.

*Ol-fac'to-ry.* Pertaining to smelling.

*O-li-va're.* The name of a portion of the spinal cord. Fig. 167.

*O-men'tum.* The caul. Fig. 122.

*O'mo.* The shoulder. Names compounded with this word belong to muscles attached to the scapula.

*Oph-thal'mic.* Belonging to the eye.

*Op-po'nens.* That which acts in opposition to some thing. The name of two muscles of the hand. Fig. 72.

*Op'ti-cus, Op'tic.* Pertaining to the eye.

*Or-bic'u-lar.* A circle.

*Or-bic-u-la'ris.* A name applied to a muscle. Fig. 58.

*Or'gan.* A part of the system destined to exercise some particular function.

*Or-gan'ic.* Pertaining to an organ.

*O'ris.* Of the mouth.

*Os.* A bone. The mouth of any thing.

*Os'sa.* Bones.

*Os'se-ous.* Belonging to bones.

*Os'si-fy.* To convert into bone.

*Os-si-fi-ca'tion.* The formation of bones in animals.

*O-va'le, is.* Round.

*Ox-al'ic.* The name of a poisonous acid.

*Ox'y-gen.* The name of one of the elements of the atmosphere.

*Pa-la'tum.* The palate. The roof of the mouth. Fig. 16.
*Pal'pe-bra.* The eyebrows.
*Pal-pe-bra'rum.* One of the eyebrows.
*Pal-ma'rus.* The name of a muscle of the arm. Fig. 68.
*Pan'cre-as.* The name of one of the digestive organs. Fig. 102.
*Pan-cre-at'ic.* Belonging to the pancreas.
*Pa-pil'la, æ.* Small conical prominences.
*Pa-ren'chy-ma.* The substance contained between the blood-vessels of an organ.
*Par-i-e'tal.* The name of a bone of the head. Fig. 15.
*Par-i-e'tes.* The walls of a cavity.
*Pa-rot'id.* The name of the largest salivary gland. Fig. 91.
*Pa-thet'i-cus, ci.* The name of the 4th pair of nerves. Fig. 168.
*Pa-tel'la, æ.* The knee-pan.
*Pec'tus.* The chest.
*Pec'to-ral.* Pertaining to the chest.
*Pec-ti-ne'us.* The name of a muscle of the leg. Fig. 73.
*Pe'dis.* Of the foot.
*Pel'i-tongs.* Masses of fat. Fig. 12.
*Pel'li-cle.* A thin crust or film.
*Pel'vic.* Relating to the pelvis.
*Pel'vis.* The basin formed by the large bones at the lower part of the abdomen. Fig. 24.
*Per-i-card'i-um.* A membrane that encloses the heart.
*Per-i-os'te-um.* The fibrous membrane that surrounds the bones.
*Per-i-stal'tic.* A movement like the crawling of a worm.
*Per-i-to-ne'um.* The thin membrane that lines the abdominal cavity, and forms the exterior coat of the abdominal organs.
*Per-o-ne'al.* Relating or belonging to the fibula.
*Per-spi-ra'tion.* The evacuation of the fluids of the body through the pores of the skin.
*Pes.* The foot.
*Pha'rynx.* The upper part of the œsophagus. Fig. 92.
*Pha-ryn-ge'al.* Relating to the pharynx.
*Pha-ryn'ges.* The name of muscles connected with the pharynx.
*Pha'lanx, ges.* Three rows of small bones, forming the fingers or toes. Fig. 31.
*Pha-lan-ge'al.* Belonging to the toes or fingers.
*Phren'ic.* Belonging to the diaphragm.
*Pi-a Ma'ter.* A very delicate membrane which immediately covers the brain.
*Pig-men'tum.* Pigment, coloring matter.
*Pis'i-form.* One of the metacarpal bones. Fig. 30.
*Pi-tu'i-ta-ry.* A membrane that secretes mucus or phlegm.
*Pla'num, i.* Plain, level, smooth.
*Plan'tar, Plan-ta'ris.* The sole of the foot.
*Pla-tys'ma.* Applied to thin, broad muscles. Fig. 58.
*Pleu'ra, æ.* A thin membrane that covers the inside of the thorax, and forms the exterior coat of the lungs. Fig. 109.
*Pleu'ral.* Relating to the pleura.
*Plex'us.* Any union of nerves, vessels, or fibres, in the form of network. Fig. 182.
*Pneu-mo-gas'tric.* Belonging or relating to both the stomach and lungs.
*Pol'lex, Pol-li'cis.* The thumb or great toe.
*Pop-lit-e'al.* Pertaining to the ham or knee-joint. A name given to various parts.
*Por'ti-o Dura.* The facial nerve. Fig. 182.
*Por'ti-o Mol-lis.* The auditory nerve. Fig. 198.
*Pos'ti-cus.* Behind, posterior.
*Pri'mus.* First.
*Pro-bos'cis.* The snout or trunk of an elephant and of other animals.
*Proc'ess.* A prominence or projection.
*Pro-na'tor.* The muscle of the fore-arm that moves the palm of the hand downward. Fig. 69.
*Pso'as.* The name of two muscles of the leg. Fig. 73.

*Pul'mon.* The lungs. Fig. 108.

*Pul-mon'ic,* *Pul-mo-na'-ry,* *Pul-mo-na'lis.* Belonging to or relating to the lungs.

*Py-lo'rus.* The lower orifice of the stomach with which the duodenum connects. Fig. 104.

*Py-lor'ic.* Pertaining to the pylorus.

*Py-ram-i-da'le.* A term applied to triangular eminences upon the medulla oblongata. Fig. 167.

*Py-ram-i-da'lis.* The name of one of the muscles of the abdomen. Fig. 61.

*Quad-ri'ceps, Quad-ra'tus.* A term applied to muscles of a quadrangular form.

*Quad-ri-gem'i-ni.* The name of some small bodies at the base of the brain.

*Ra'di-us.* The name of one of the bones of the fore-arm. Fig. 29.

*Ra-di-a'lis.* Radial; belonging to the radius.

*Ra'mus.* A branch. A term applied to the projections of bones. Fig. 17.

*Re-cep-tac'u-lum Chy-li.* A receptacle of the chyle. Fig. 99.

*Rec-re-men-ti'tial.* Consisting of superfluous matter separated from that which is valuable.

*Rec'tus, a.* Straight, erect.

*Rec'tum.* The third and last portion of the intestines. Fig. 100.

*Re-cur'rent.* To run back.

*Re'gion.* Determinate spaces on the surface of the body, or of different organs.

*Re'nal.* Pertaining to the reins or kidneys.

*Res'ti-forme, ia.* The name applied to two projecting bodies upon the medulla oblongata. Fig. 167.

*Ret'i-na.* The essential organ of sight. One of the coats of the eye. Fig. 190.

*Re-sid'u-um.* Residue. The waste remains of the food.

*Re-sid'u-al.* Remaining after a part is taken.

*Res-pi-ra'tion.* The act of breathing.

*Res'pi-ra-to-ry.* Serving for respiration.

*Rhom-boi'de-us.* The name of muscles of the back and neck. Fig. 64.

*Rhom-boid'al.* Having the shape of a rhomboid.

*Ro-ta'tion.* A rolling movement.

*Ro-tund'um, a.* Round.

*Ru'ga, æ.* Plaits, or wrinkles.

*Sac'cu-lus.* A little sac.

*Sa'crum.* The bone which forms the posterior part of the pelvis, and is a continuation of the vertebral column. Fig 24.

*Sa'cral.* Pertaining to the sacrum.

*Sa-cro-Il'i-ac.* That which relates to the sacrum and ileum.

*Sag-it'tal.* The name of a suture that unites the parietal bones. Fig. 14.

*Sa-li'va.* The fluid secreted in the mouth.

*Sal'i-va-ry.* That which belongs to the saliva.

*San-guin'e-ous.* Full of blood.

*San-guin-a'ria.* The name of a plant. Blood-root.

*Sa-phe'nous.* A name given to veins of the lower extremities. Fig 159.

*Sar-to'ri-us.* A muscle upon the anterior part of the thigh. Fig. 73.

*Sca'la, æ.* Cavities of the cochlea. Fig. 197.

*Sca-le'nus, i.* A name applied to muscles of the neck. Fig. 130.

*Sca'phoid.* A name given to several parts. Fig 30.

*Scap'u-la.* The shoulder-blade. Fig. 27.

*Scap'u-lar.* Pertaining to the scapula.

*Scarf-skin.* The outer, thin integument of the body. The cuticle.

*Sci-at'ic.* The name of the large nerve of the leg. Fig. 182.

*Scle-rot'ic* A membrane of the eye. Fig. 190.

*Se-ba'ce-ous.* Pertaining to fat, unctuous matter.

*Se-cre'tion.* To separate. The organic functions of several glands, by which they separate from the blood the material which they respectively demand for their several purposes.

*Se-cun'dus, di.* Next, but inferior. A term applied to muscles.
*Sem-i-Mem-bra-no'sus.* The name of a muscle of the leg. Fig. 74.
*Sep'tum.* A membrane that divides two cavities from each other.
*Se'rous.* Thin, watery. Pertaining to serum.
*Se'rum.* One of the constituents of the blood.
*Ser'ra-tus.* The name of a muscle of the trunk. Fig. 62.
*Sig'moid.* Resembling the Greek ς.
*Si'nus.* A cavity, the interior of which is more expanded than the entrance.
*Skel'e-ton.* The aggregate of the hard parts of the body. The bones.
*So-le'us* The name of a muscle of the leg. Fig. 76.
*Sphe'no.* Wedge-shaped.
*Sphe'noid.* A bone of the skull.
*Sphinc'ter.* A muscle that contracts or shuts.
*Spi'nal Cord.* A prolongation of the brain. Fig. 174.
*Spi-na'tus.* A name applied to a muscle. Fig. 64.
*Spine.* A thorn. The vertebral column. Fig. 173.
*Splanch'nic.* Relating to the internal organs.
*Spleen.* The milt. Fig. 103.
*Splen'ic.* That which relates to the spleen.
*Stra'tum, a.* A bed or layer.
*Sty'loid.* An epithet applied to processes that resemble a style or pen.
*Sub.* Under. A prefix to the names of several muscles.
*Sub-cla'vi-us.* A name applied to certain parts under the clavicle.
*Su-pe'ri-or.* The upper of two parts.
*Su'ture.* The seam or joint which unites the bones of the skull. Fig. 14.
*Sy-no'vi-a.* The lubricating fluid of the joints.
*Sys'tem.* An assemblage of organs, composed of the same tissues, and intended for the same functions.
*Sys-tem'ic.* Belonging to the general system.

*Tar'sal.* That which relates to the tarsus.
*Tar'sus.* The posterior part of the foot. Fig. 34.
*Tem-po-ra'lis.* The name of a muscle attached to the temple. Fig. 59.
*Ten'don, do.* A hard, insensible cord or bundle of fibres, by which a muscle is attached to a bone.
*Ten'di-na, æ.* Pertaining to a tendon.
*Tens'or.* A muscle that extends a part. Fig. 73.
*Ten-tac'u-la.* A filiform process or organ on the bodies of various animals.
*Ten-to'ri-um.* A process of the dura mater. Fig. 174.
*Te'res.* An epithet given to many organs, the fibres of which are collected in small bundles. Fig. 66.
*Ter'ti-us.* Third.
*Thal'a-mus, mi.* A prominence of the brain at which the optic nerve originates.
*Tho'rax.* The chest. Fig. 20.
*Tho-rac'ic.* Pertaining to the chest.
*Thy'roid.* Resembling a shield. A cartilage of the larynx. Fig. 128.
*Tib'i-a.* The large bone of the leg. Fig. 33.
*Tib'i-al.* Pertaining to the tibia.
*Tis'sue.* Texture or organization of parts.
*Ton'sils.* A glandular body at the passage from the mouth to the pharynx. Fig. 104.
*Tra'che-a.* The wind-pipe. Fig. 92.
*Tra'che-al.* Pertaining to the trachea.
*Tra-che'lo Mas-toi-de'us.* A muscle of the neck. Fig. 65.
*Tra-pe'zi-us.* A bone of the wrist. Fig. 30.
*Trans-ver'sus.* Lying across, or being in a cross direction. Fig. 78.
*Trans-ver-sa'lis, les.* A muscle of the abdomen. Fig. 62.
*Tri'ceps.* Three. A name given to muscles that have three attachments at one extremity. Fig. 67.
*Tri-cus'pid.* Triangular valves of the heart. Fig. 139.
*Tri-que'tra.* Small irregular bones of the skull. Fig. 14.

*Troch'le-a.* A pulley-like cartilage, over which the tendon of a muscle of the eye passes. Fig. 60.
*Troch'le-a-ris.* The name of a muscle of the eye. Fig. 60.
*Trunk.* The principal part of the body, to which the limbs are articulated.
*Tu'ber-cle.* A small push, swelling, or tumor on animal bodies.
*Tu-ber-os'i-ty.* Protuberance.
*Tu'nic.* A coat. An envelope.
*Tu'ni-ca.* Pertaining to the tunic.
*Tym'pa-num.* The middle ear. Fig. 196.

*Ul'na.* A bone of the fore-arm. Fig. 29.
*Ul'nar.* Pertaining to the ulna.
*Un'ci-form.* Hook-shaped. A bone of the carpus. Fig. 30.
*Unct'u-ous.* Fat; oily.
*U-ve'a.* Resembling grapes. A thin membrane of the eye.
*U'vu-la.* A soft body, suspended from the palate, near the aperture of the nostrils, over the glottis.

*Valve.* Any membrane, or doubling of any membrane, which prevents fluids from flowing back in the vessels and canals of the animal body.
*Val-vu'la, æ.* A valve.
*Vas'cu-lar.* Abounding in vessels.
*Vas'tus.* Great. A name applied to muscles of the leg. Fig. 73.
*Veins.* Vessels that convey blood to the heart.
*Ve'nous.* Pertaining to veins.
*Ven'tri-cle.* A small cavity of the animal body.
*Ven-tric'u-lar.* Relating to ventricles.
*Ver-mic'u-lar.* Resembling the motion of a worm.
*Verm'i-form-is.* Having the form or shape of a worm.
*Ver'te-bra, æ.* A joint of the spinal column, or back-bone. Fig. 22.
*Ver'te-bral.* Pertaining to the joints of the spine.
*Ves'i-cle.* A bladder-like cavity.
*Ves'ti-bule.* A cavity belonging to the ear. Fig. 197.
*Vi'rus.* Foul matter of an ulcer. Poison.
*Vis'cus.* The contents of the thorax and abdomen, as the heart, liver.
*Vi'tal.* Pertaining to life.
*Vit're-ous.* Pertaining to glass. A humor of the eye. Fig. 199.
*Vo'lar.* Belonging to the palm of the hand.
*Vo'mer.* One of the bones of the nose. Fig. 15.

*Zo'nu-la.* A zone or belt.
*Zyg-o-mat'i-cus.* A name applied to a muscle of the face. Fig. 59.

# RECOMMENDATIONS.

SPRINGFIELD HIGH SCHOOL, MARCH, 1846.

DR. CUTTER,

Dear Sir, — I have adopted your work on Anatomy and Physiology as a Text-Book. Our Town School Committee were unanimous in favor of its introduction, and I am fully confident, that it will be found a judicious selection. I have heretofore used several kinds of text-books on this subject, which have been highly esteemed, and justly so, by teachers generally; but the superiority of this work is so obvious on every page, that I have not hesitated for a moment to give it the preference over all others.

Among its excellences will be found an unusually clear description of what is *essential*, free from useless *verbiage*. No work of the kind has ever been published, so full of illustrations, and these are remarkably adapted to render the subject clear to the comprehension of the pupil. While *technical* language is used, it is confined chiefly to particular description of plates, or topics independently, leaving the popular instruction so plain that a child can understand it.

As a Text-Book for schools, or a work adapted to general reading, I believe it will be found superior to anything that has ever yet been laid before the public.

A. PARISH,

*Principal of the Springfield High School.*

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WESLEYAN ACADEMY, WILBRAHAM, MASS., FEB. 18th, 1846.

The undersigned having examined the Second Edition of Anatomy and Physiology, by Calvin Cntter, M. D., can cordially recommend that work to an intelligent and inquiring public. The subject treated of is one of vast importance to the world, and one not yet half appreciated. Were our teachers in academies and common schools fnlly acquainted with the structure of the hnman system, and the laws of health, they would be worth infinitely more to the community; and were fathers, and especially mothers, better instructed in the science and constitntion of man, they could not fail to discharge with greater usefulness the great responsibilities resting upon them.

We heartily recommend Dr. Cutter's work to all who wish for more full information upon the subject of their own frame and organization.

ROBERT ALLYN,

*Principal of Wesleyan Academy.*

ISAAC T. GOODNOW,

*Teacher of Natural Science.*

BRIDGEWATER, FEB. 21st, 1846.

MY DEAR SIR,

During the first year that I had the charge of this Institution, two deservedly popular and able works on Physiology were adopted as text-books. Very soon after Dr. Cutter's treatise on the same subject made its appearance, it was introduced into my school in place of those above-mentioned. I have had, therefore, a fair opportunity of judging of its adaptation as compared with other works, to the wants of our schools and academies. For the purposes of instruction, it appears to me that it is rendered superior to other treatises. 1st. Because it is adorned with a far greater number of Plates, which I find engages the attention and deeply interests the mind of the pupils — presenting to them striking occular illustrations of the form and structure of the human system.

2d. Because its lucid arrangement and clear style, divested of technical terms as far as the subject will possibly permit, render it so intelligible, that scholars of sixteen years of age, and even younger minds, may comprehend it, and with some explanation from the teacher, may study it with advantage and delight.

3d. Because questions, deduced from the contents, with much discrimination, have been placed at the bottom of each page, to lead the *younger* pupils to direct their attention to those parts of the page which are of the most practical importance; and finally, because the Appendix is full of extremely useful directions, not to be found in other productions of this kind, and the knowledge of which may enable any one, in cases of sudden accidents, to relieve suffering and save life.

THEODORE P. DOGGETT,
*Preceptor of Plymouth County Academy*

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CHARLESTOWN, 30th JAN. 1846.

C. CUTTER, M. D.,

Dear Sir, — I have examined the Second Edition of your work on 'Anatomy and Physiology, for Schools and Families.' I am fully satisfied with it, and shall use it in my school.

It embraces the departments of Anatomy, Physiology and Hygiene, sufficiently minute and extensive for schools or general reading, and it cannot fail to find favor. The *practical* matter it contains greatly enhances its value. Its numerous engravings are well adapted to illustrate the text, and to interest the young learner in this most interesting study.

Very respectfully, your obedient servant,

SOULE CARTEE,
*Principal of Boylston Chapel School for Young Ladies.*

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ANDOVER, APRIL 14th, 1846.

CALVIN CUTTER, M. D.,

Dear Sir, — The interest which is beginning to be felt in the study of the human system, affords one of the most satisfactory indications that the cause of education is advancing. I have examined with care your work on 'Anatomy and Physiology,' and am highly pleased with its plan and execution. It is *plain*, *practical*, and *thorough*, and deserves to find a place among the standard text-books of our schools.

Yours very truly,

W. H. WELLS,
*Teacher of Phillips Academy, Andover, Mass.*

Collegiate Institute, Rochester, Dec. 8th, 1845.

This is to certify, that I have examined a work entitled, 'Anatomy and Physiology, Designed for Schools and Academies. By Calvin Cutter, M. D.,' and that I consider it a very superior work of the kind. The manner in which the principles of the science are presented to the student, is such that he cannot fail to be deeply interested in the study. The correctness and care with which the numerous engravings have been executed, render this book one of great value to those teachers who desire to have their pupils *understand* what they study. It is with pleasure, therefore, that I recommend it to the patronage of the institutions for which it was designed.

N. W. BENEDICT,

*Associate Principal and Prof. of Latin and Greek Languages.*

I fully concur in the opinion of Prof. Benedict, as expressed above.

LEANDER WETHERELL,

*Principal of the English Department of the Rochester Collegiate Institute.*

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Warren, Feb. 3d, 1846.

Dr. Cutter,

Dear Sir, — It gives us much pleasure to express to you our entire satisfaction with the text-book on Anatomy and Physiology, which you have prepared for schools. We have used it for the past six months in our school, and do not hesitate to say, that we consider it superior to any other book of the kind with which we are acquainted.

We are particularly pleased with the Chapters on the 'Skin and Digestive Organs.' The uses and abuses of these parts of the animal system are therein so clearly and forcibly presented to the mind of the student, that while he is becoming informed, he cannot but be materially benefited by their perusal. We shall henceforth make your work our standard text-book, in the place of Lee's, formerly used.

Yours respectfully,

J. P. GREEN, A. M.,
H. B. UNDERHILL, A. B.,

*Associate Principals of Quaboag Seminary, Warren, Mass.*

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Swanzey, N. H., May 1st, 1846.

Calvin Cutter, M. D.,

Dear Sir, — I have examined your late work on 'Anatomy and Physiology,' and take great pleasure in testifying my cordial approbation of it. Combining, as it does, the principles of *Anatomy* and *Physiology*, it supplies a want long felt by teachers and parents, which no other popular work fully meets. The numerous and well executed engravings afford a very good substitute for the Manikin, which is too expensive for most schools. The 'Practical Suggestions' are of incalculable value to all who wish to preserve soundness of body and mind.

We have introduced it into our Institution, and find it a valuable aid in the too much neglected study of the human system.

Yours truly,

JOHN S. LEE, A. B.

*Principal of the Mt. Cæsar Seminary.*

WILLISTON SEMINARY, EAST HAMPTON, FEB. 6th, 1846.

DR. CUTTER,

Dear Sir, — I thank you for your valuable work on 'Anatomy and Physiology, designed for Schools and Families.' I have examined it with great interest, and regard it as just the work to be introduced into our schools. It will be used as a text-book in this Seminary.

Accept the assurance that I am yours, very truly and respectfnlly,

S. WRIGHT.

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YOUNG LADIES' INSTITUTE, PITTSFIELD, MARCH 12th, 1846.

C. CUTTER, M. D.,

Dear Sir, — I thank you for the copy of your work on Anatomy and Physiology. The thorough examination I have given it has afforded me much gratification; and I now take pleasure in recommending this work, as in my opinion decidedly better adapted to general use in schools than any other with which I am acquainted.

Yours truly,

W. H. TYLER.

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BARRE HIGH SCHOOL, OCT. 8th, 1845.

CALVIN CUTTER, M. D.,

Dear Sir, — I have examined with care, your work on 'Anatomy and Physiology, designed for Schools and Families,' and am very favorably impressed both with its plan and execution. It contains much that is *practical* as well as instructive; and is recommended by its *brevity*, *clearness*, and *comprehensiveness*.

I think it preferable, as a text-book, to any other treatise upon the same subject now in use.

A. WELLINGTON,
*Principal of the Barre High School.*

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DUXBURY, MAY 11th, 1846.

CALVIN CUTTER, M. D.,

Dear Sir, — I have given your work on Physiology a careful perusal. I have examined it with especial reference to its adaptation as a text-book for schools. It meets a want which I have for some time felt — the want of a book upon the subject of Physiology, which does not sedulously avoid accuracy of detail, and deal alone in loose generalities, but which seeks, by thorough descriptions, clear illustrations and useful hints, to afford pupils that kind of knowledge which will fit them to act understandingly for themselves and others in cases of emergency, as well as properly to regulate and provide for the daily wants of their systems. The superiority of the work over any yet introduced into our schools, is, in my mind, so evident, that I am disposed to think that it will be adopted by all those teachers who examine it for themselves — that the work will be its own best recommendation.

Very truly, yours, &c.,

JAMES RITCHIE,
*Principal of Duxbury Academy.*